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Vol. XXVIII.—No. 12. DECEMBER, 1944

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THE BRITISH JOURNAL OF OPHTHALMOLOGY,

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THE ROYAL LONDON OPHTHALMIC HOSPITAL REPORTS,

THE OPHTHALMIC REVIEW,

AND

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LONDON:

THE BRITISH JOURNAL OF OPHTHALMOLOGY LTD.

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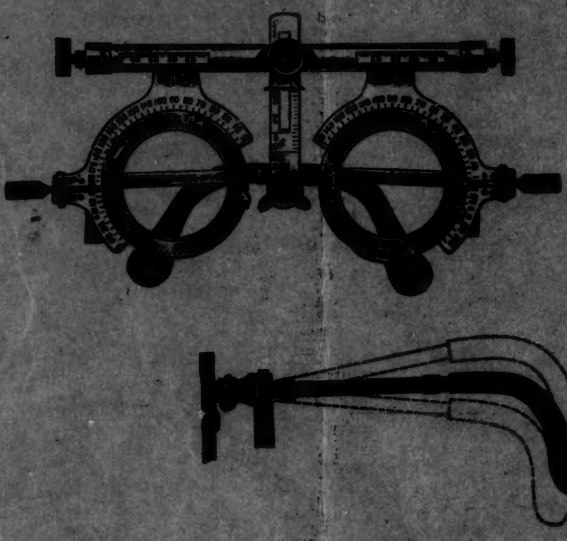

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THE BRITISH JOURNAL

OF

OPHTHALMOLOGY

DECEMBER, 1944

COMMUNICATIONS

RETINAL MICRO-ANEURYSMS AND PUNCTATE HAEMORRHAGES*

BY

A. J. BALLANTYNE *and* A. LOEWENSTEIN

FROM THE TENNENT INSTITUTE, GLASGOW UNIVERSITY, PROFESSOR W. J. B. RIDDELL

IN several recent papers we have directed attention to the minute red dots occasionally encountered in the retinopathy of diabetes, and included in the so-called deep, punctate haemorrhages which form part of the ophthalmoscopic picture of that disorder.

Certain observations of the unstained retina, examined in bulk, raised doubts of the haemorrhagic character of these spots, and, without being able to differentiate the lesions clearly, we concluded that some, at least, were aneurysms. Further study of the material has now made it possible to define more clearly the characters which distinguish punctate haemorrhages from aneurysms, and to show that the latter may be of outstanding importance in the diagnosis of diabetes.

In the initial observations of the unstained retina, viewed on the flat, the lesions in question took the form of perfectly round, mulberry-like collections of red blood corpuscles, enclosed in an

* Received for publication, July 10, 1944.

envelope, sometimes represented by a thin structureless membrane (Fig. 1), sometimes by a thicker wall of double contour (Fig. 2), and sometimes by a wall of considerable thickness (Fig. 3). Some of the bodies were surrounded by a yellowish zone, due to diffuse blood pigment, others were associated with haemorrhage (Fig. 6).

The difficulty in determining the true nature of these bodies lay in our failure at first to find any connection with a blood vessel; and they were described as " encysted haemorrhages." In these first instances the bodies were discovered accidentally, and had not been identified with a previously observed ophthalmoscopic lesion. The difficulty of tracing the vascular connection will be appreciated by those who examine the unstained retina by this useful technique. Naturally the histological details only become apparent on somewhat prolonged study, employing variations in the diaphragm aperture, obliquity of the illumination and other manoeuvres; but the visibility of the smaller retinal vessels depends almost entirely on their content of erythrocytes. It is very difficult to see the capillaries unless they contain sufficient red corpuscles to enable one to trace their course. In favourable cases the complete capillary networks can be followed, while in others no trace of capillaries can be found. Figs. 1, 3 and 4 give examples of micro-aneurysms, with their capillary connections thus indicated by a more or less broken series of red corpuscles.

Even after we were able to find the capillary connection in a sufficient number to demonstrate the aneurysmal character of the bodies, it remained to identify them with the so-called punctate haemorrhages of the fundus picture, and to establish their characteristics in sections of the retina cut and stained in the usual way. The illustrations give a convincing demonstration of the true nature of the lesions.

We shall deal in this paper with their ophthalmoscopic and histological characters, and not with their significance as a diagnostic feature of the diabetic fundus.

In Fig. 5 we have a characteristic appearance and grouping of the spots, as seen with the ophthalmoscope, in the central area of the fundus. Most of them have no visible connection with a retinal vessel, but in a few instances they appear to be attached to the finer twigs of the small peri-macular vessels. Often, as in this case, two distinguishable lesions occur together; small perfectly round bodies, sometimes recognised to be globular by the presence of a central light reflex, and other spots, of similar or larger size, round or polygonal in form, and often of mossy outline.

The former are the micro-aneurysms to which we wish to call attention, the latter are petechial or punctate haemorrhages. These two lesions can be easily distinguished in the bulk retina viewed on the flat, and we often find them together as in Fig. 6, where

the aneurysm has obviously ruptured to form what no doubt appears ophthalmoscopically as a "punctate haemorrhage."

In the fundus from which Fig. 5 was taken, the number of micro-aneurysms has varied very little during the two years of regular observation; but it is probable that the actual number is greater than we can see.

Fig. 7 is a map of the fundus of another case, as seen with the slit-lamp in the post-mortem specimen; but even this does not give

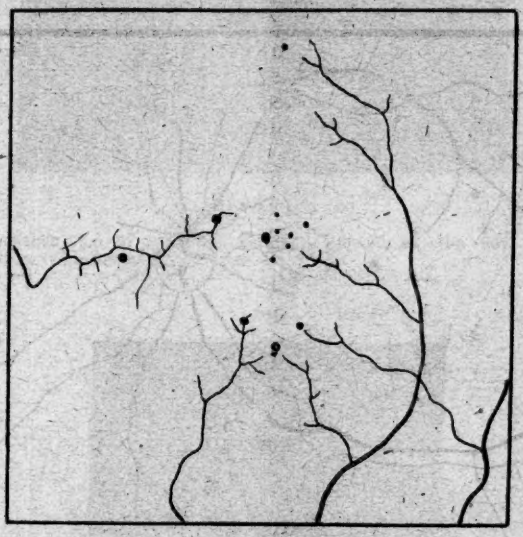

FIG. 5.

Ophthalmoscopic view of micro-aneurysms around the macula. Case of diabetes.

a complete idea of their number, for serial sections of a portion of the same retina, 3 mm. in diameter, showed as many as thirty such aneurysms.

Coming to the stained sections, which were made both on the flat (Fig. 8) and in the vertical direction (Figs. 9, 10 and 11), we have the same difficulty in tracing the vascular connections of the aneurysms; but sometimes this can be seen in the shape of a procession of erythrocytes or a strand of endothelial cells (Figs. 3, 4, 8 and 12).

It has been customary to describe these punctate lesions as *deep* haemorrhages, but it is interesting to note that they are to be found, almost without exception, in the inner nuclear layer. A

few may be discovered in the nerve fibre and ganglion cell layers (Fig. 10), and still fewer in the outer molecular (Fig. 11). They occur, in fact, on the capillaries which link the more superficial capillary network in the nerve fibre layer with the deeper plexus at the outer boundary of the inner nuclear layer.

The sections confirm certain features of the lesions which have been observed in the bulk specimens of the unstained retina; for example, the clear outline and rounded form, the varying thickness of the enclosing envelope, and the occasional escape of blood

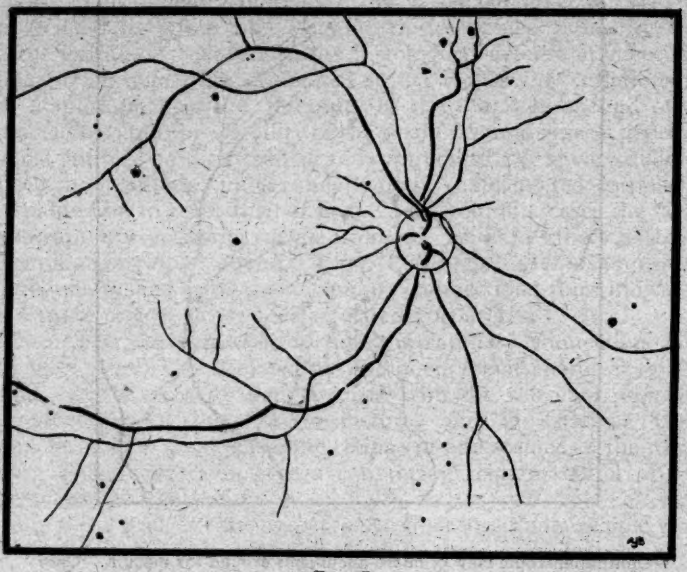

FIG. 7.

Fundus of the excised eye as seen with the slit-lamp. Micro-aneurysms and haemorrhages.

by rupture or by leakage. They also throw light on a phenomenon sometimes observed ophthalmoscopically to which attention has already been drawn (2). If these micro-aneurysms are watched over a long period one occasionally sees the appearance of a faint halo, which gradually becomes whiter and broader, encroaching on the surface of the red dot, until this latter is covered and converted into a white spot.

In microscopic preparations we sometimes observe a transformation in the aneurysms which may explain the formation of such white spots. This takes the form of a proliferation and

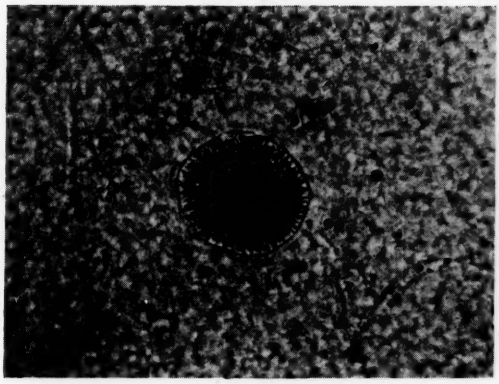

FIG. 1.

Micro-aneurysm in unstained retina. Viewed on the flat. The capillary connections can be seen.

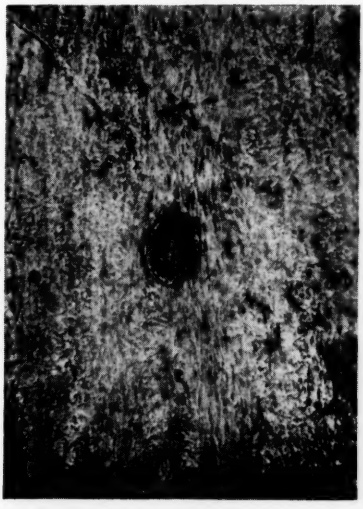

FIG. 2.

Micro-aneurysm in unstained retina, viewed on the flat. No vascular connection can be traced.

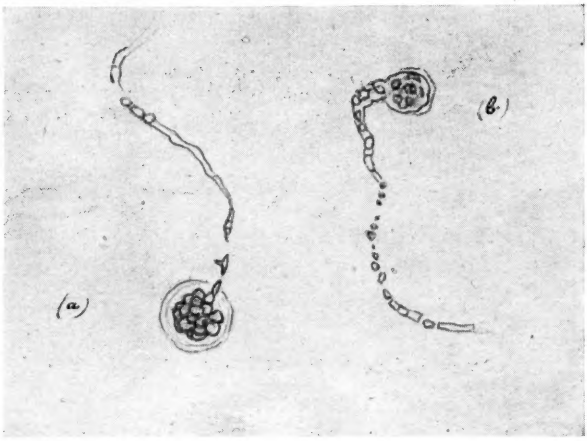

FIG. 3.

Micro-aneurysms in unstained retina, viewed on the flat. They are attached to capillaries (*a*) 35μ (*b*) 26μ in diameter.

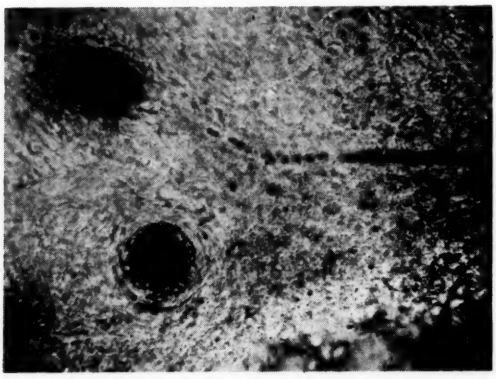

FIG. 4.

Retina in bulk, unstained, seen on the flat. Branching capillary with two micro-aneurysms.

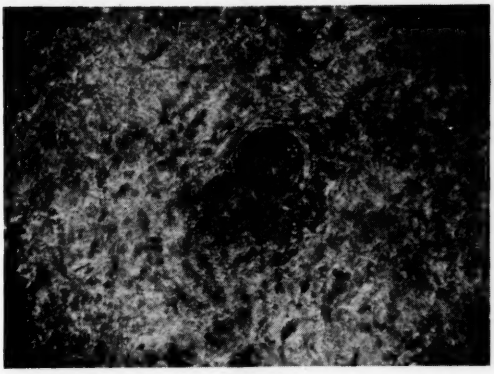

FIG. 6.

Retina in bulk, unstained, seen on the flat. Micro-aneurysm with haemorrhage.

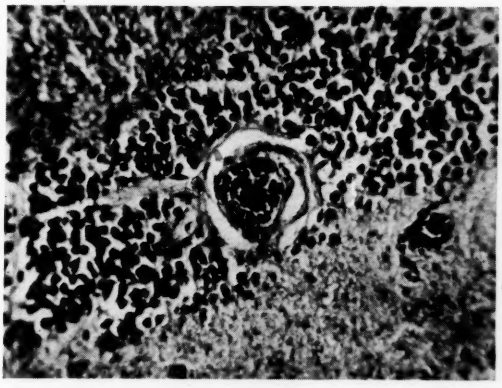

FIG. 8.

Section of the retina on the flat, with micro-aneurysm in inner nuclear layer. Capillary connection visible.

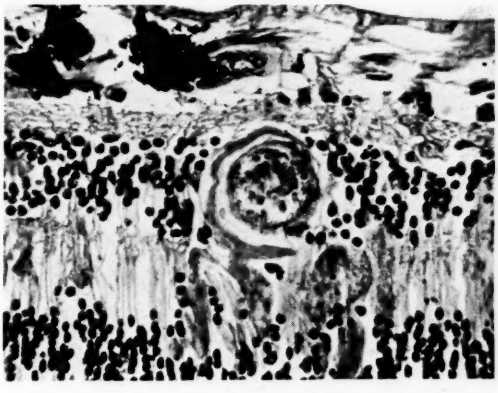

FIG. 9.

Vertical section of retina with micro-aneurysm in inner nuclear layer.

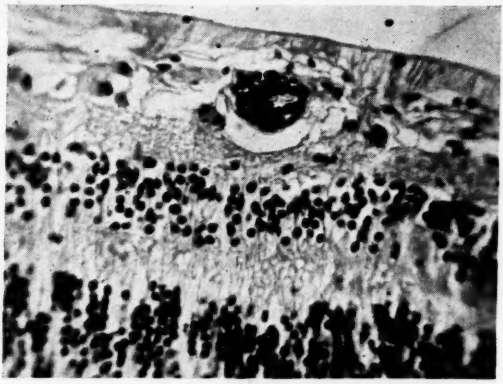

FIG. 10.
Vertical section of retina with micro-aneurysm in ganglion cell layer.

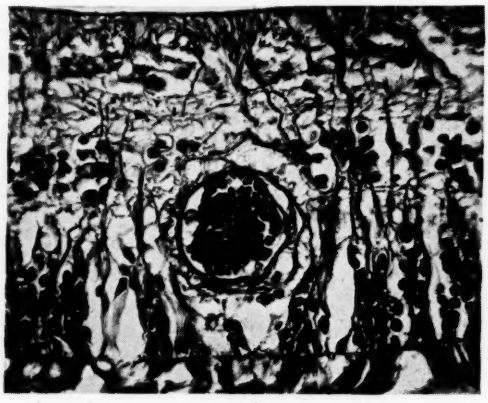

FIG. 11.
Vertical section of retina with micro-aneurysm mainly in outer molecular layer.

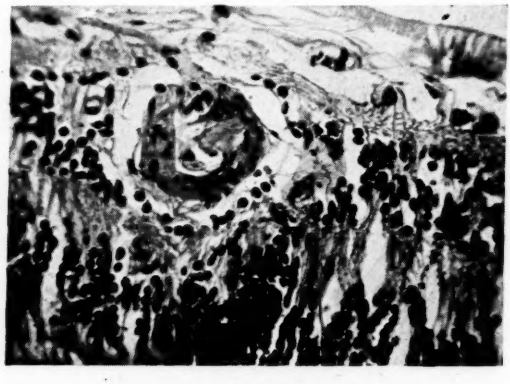

FIG. 12.
Vertical section of retina with micro-aneurysm in inner nuclear layer which has become thrombosed. Capillary connection visible.

swelling of the endothelium with subsequent thrombosis, and formation of a cicatricial nodule (Fig. 12). The formation of the micro-aneurysms is preceded by changes in the vascular endothelium which lead to venous and capillary stasis, and the result is somewhat similar to the sclerotic changes which appear as sheathing of the retinal veins when stagnation of the circulation has resulted from thrombosis. Thrombosis may be both a result and a cause of the circulatory stasis: in other words, a vicious circle may be established in consequence of an initial pathological change in the vascular endothelium. Both in the bulk specimens and in sections, the older, thrombotic, aneurysms are associated with deposits of haematogenous pigment.

The sections show not only the almost invariable occurrence of the aneurysms in the internal nuclear layer, but also a remarkable uniformity in their size. They range in size from 30 to 90 μ, but most of them measure from 50 to 60 μ, and they are contained entirely within the inner nuclear layer.

Proof of the identity of the micro-aneurysms with the bodies seen in ophthalmoscopic examination, and in the unstained retina in bulk, is completed by the examination of uninterrupted serial sections, in which it can be shown not only that they are compact and well defined bodies, but that they are spherical in shape. This helps to distinguish them from small haemorrhages. The latter often occur in the middle layers of the retina and may, in individual sections, have a round or oval form, resembling the aneurysms, but if they are followed through successive sections they will be found to vary in size and shape, and to be without any enclosing membrane. Viewed on the flat, such haemorrhages sometimes assume the form of an irregular network.

Uninterrupted serial sections also serve to distinguish micro-aneurysms from retinal vessels, which may readily, in single sections, be mistaken for aneurysms.

The globular micro-aneurysms are, of course, only one variety of the ectasiae which occur on the retinal capillaries. Sometimes relatively long segments of the capillaries are so dilated as to form sausage-shaped loops, or they may form complex coils or networks which are apt to be partly obscured by haemorrhage. These, however, are usually associated with the grosser forms of retinal vascular disease and their consequent haemorrhages and exudates.

The diameter of the micro-aneurysms may be as much as 10 or 15 times that of the parent capillary, and it is not surprising that the wall is often stretched so thin as to be scarcely recognisable; nor is it surprising that it allows blood to escape either by diapedesis or by rupture.

Summary

It can be shown that many, if not most, of the so-called punctate haemorrhages characteristically seen in diabetic retinopathy are actually capillary aneurysms.

By examination of the unstained retina in bulk, as well as in vertical and flat serial sections, these bodies are seen to be compact collections of red blood corpuscles, globular in form, and with an average diameter of 50 to 60 μ, enclosed in a wall of varying thickness. With few exceptions they occur in the inner nuclear layer, in the course of the capillaries which link the deeper and more superficial capillary plexuses of the retina.

They may be a source of haemorrhage by diapedesis or by rhexis, and many of them are seen to undergo a process of thrombosis and cicatrisation. They represent a stage in the vicious circle in which changes in the capillary endothelium lead to a stasis in the circulation which, in turn, causes further vascular changes, especially on the venous side of the retinal circulation.

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A SIMPLE METHOD OF DEMONSTRATING NYSTAGMUS IN CERTAIN MINERS*

BY

A. CHRISTIE REID

NOTTINGHAM

A LARGE experience in the assessment of cases claiming compensation under the Workmens' Compensation Act for miners' nystagmus has convinced me that in the vast majority the complaints of subjective symptoms, headaches, dizziness, loss of sleep, etc., are real and not feigned, though, of course, some allowance must be made for obsessional cases, and perhaps more recently a new form of resistance has arisen among some of the Bevin lads who have been picked by ballot from among recruits for the forces and ordered to go down the pits after a short training and testing period.

* Received for publication, September 27, 1944.

Some of these lads have a genuine disability in the dark if they have to discard glasses worn for some years of school life. The high hypermetropes should be refused at once[1]; and even the low or moderate myopes, if they have become very dependent on their glasses, may prove very difficult when they are deprived of these on going down.

It is different with the young myopic miner who has from the first worked below ground, may be before he has had glasses. He may have surprisingly good unaided vision at 5 metres, and has accustomed himself to the deprivation of his glasses in the pit. Many high myopes carry on at the coal face without glasses till 50 years of age or more. But this note is designed to fill a gap in the diagnosis of a class of case in which, with definite distress at work involving stooping, it is difficult to demonstrate the nystagmus when the man sits upright in a chair. He states that as soon as he straightens up, the oscillations cease, and even a rapid approach with the ophthalmoscope cannot catch them.

To get over this I employ a concave mirror 12 cm. diameter having a curvature of −0·75 D.

The patient stoops while sitting or kneeling and fixes his gaze on this, and when he exclaims that the movements have begun, a beam from a pocket torch is directed on the eye being examined, and the oscillations (magnified) are seen at once in the mirror by the observer.

Incidentally, this class of case in my opinion runs counter to the recommendation of the M.R.C. in its second report of the Miners' Nystagmus Committee when, on page 19, it says:—

"We recommend that miners should be considered to have nystagmus sufficiently severely to be certified for compensation if oscillation of the eyes is constantly present even when the miner is looking at or below the horizontal level in daylight, or if it persists for five minutes in a good light with the eyes at the horizontal level after it has been induced by darkening the room and using suitable exercises."

It is the rapid on and off character of these cases dependent on stooping that makes work involving continued stooping and swinging (*e.g.*, loading trucks in a yard) difficult or even impossible without bringing on severe dizziness, etc., and the five minutes criterion seems to me highly arbitrary.

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1 *Brit. Jl. Ophthal.*, Vol. XXVII, p. 110, 1943.

AN INTRODUCTION TO BISHOP BERKELEY'S THEORY OF VISION*

BY

MICHAEL MURRAY

EDINBURGH

GEORGE BERKELEY, one of the geniuses of his age, was born in the County of Kilkenny, in 1685. His father is reported to have been a captain of horse and his mother is believed to have been a great-aunt of General Wolfe, the hero of Quebec.

Having distinguished himself at school, Berkeley entered Trinity College, Dublin, in his fifteenth year.

It is related that many of his fellow students regarded him as a fool and made fun of his eccentricities, but those who knew him well recognised some of the deep learning and originality which was later to make him world famous.

His *Theory of Vision* which is the subject of the present paper, was published in 1709. His treatise on the *Principles of Human Knowledge* appeared in the following year. The two works formed the basis of his famous Philosophy of Idealism.

Berkeley's life was, on the whole, an active one and was certainly not devoted to theorising.

He travelled extensively on the Continent and was at one time the chaplain and secretary of the English ambassador to the Italian States.

Among his friends and admirers could be mentioned Pope, Steele and Dean Swift, and not long after his return from Europe, the Duke of Grafton appointed him to the deanery of Derry. It soon became apparent, however, that this benevolent philosopher was not interested in church-preferment.

He had long been cherishing a scheme for founding a college in the Bermudas, for the purpose of educating the American Indians and converting them to Christianity.

Undaunted by difficulties, his enthusiasm raised him a small band of followers and a promise of financial help from the Government. He sailed for Rhode Island in 1728; but the promised funds were never paid and he was forced to abandon the scheme after several years. His affairs, improved, however, and in 1734 he was appointed Bishop of Cloyne.

The last years of his life were spent at Oxford: dying in 1753, he was buried in Christ Church.

Among his works is included a latin treatise on mathematics, an essay on the famous South Sea Bubble, and a tract on the medicinal properties of tar-water.

The Theory of Vision is a psychological study, and is the first

Received for publication, May 4, 1944

attempt to distinguish purely visual sensations from those in which sight is aided by the other senses. The essay is in advance of the age in which it was written, and it has been pointed out that it could have been the work of a disciple of Helmholtz.

Space forbids a reproduction of it in full, but the following is a précis, which, it is hoped, will do justice to the main arguments contained in the original.

The Theory

It is generally agreed that distance by itself cannot actually be seen. For distance is a line the end of which focuses at a point on the fundus, which point remains unaltered whether the distance is great or small.

In estimating the distances of far away objects, we have to rely on previous experience and we are aided in our judgment by considerations of size and aerial perspective and other signs which we have been taught to acknowledge. If we had not had previous acquaintance of these signs, we would have no conception of remote distances.

In dealing with near distances, it is popularly supposed that one judges distances by the optic axes of the eyes which form an angle at the object: according as to whether this angle is great or small, do we judge whether the object is far or near.

For close objects there appears to be some very necessary connection between these optical angles and our distance judgments. It would appear, therefore, that in this case, we are not dependent on experience and that anyone could judge the proximity of an object, purely by the degree of angle formed by the concurrence of his optic axes.

When using only one eye, the size of the pupil varies with the divergency of the light rays which issue from the object and fall on the eye, the point being judged nearest which is seen by the most divergent rays. Similarly, it does not seem to require experience to tell us that the more parallel the light falling on the eye, the further off is the point from which it emanates.

Although the above arguments are currently accepted as true explanations of our methods of judging distances, they are unsatisfactory for the following reasons.

In the first place, when the mind does not perceive an idea directly it must do it through the medium of some other idea.

For example, we cannot see the feelings in a man's mind, but we can perceive them by the colours they produce in his face. One often sees shame or fear in the looks of a man by watching his face turn red or pale.

Moreover, it is obvious that no idea which is not of itself perceived can be the means of perceiving another idea. If I do not

see a man's face turn red, I cannot detect the presence of shame in his mind.

Now, as was stated at the beginning, distance is by itself imperceptible, and yet it is perceived by sight; it must, therefore, be brought into view by some idea which is immediately perceived.

Firstly, it must be admitted that those angles and lines by which some men attempt to explain the perception of distance, are not seen themselves: in fact, they are not considered by those ignorant of optics. Since these lines and angles are not themselves perceived by sight, the mind cannot by them judge the distance of objects.

Secondly, these lines and angles have no real existence, being a mathematical hypothesis introduced into optics in order that the science may be treated in a geometrical way.

Now, it has already been shown that distance must be suggested to the mind through the mediation of some other idea; it remains to be shown what these ideas are.

Experience teaches us that when we look at a near object with both eyes, we alter the disposition of our eyes by lessening or widening the distance between the pupils. This turning in of the eyes is accompanied by a sensation which introduces the idea of greater or less distance into the mind.

("This 'sensation' of organic change in the eye is, of course, not seen. It belongs to our tactual experience in Berkeley's wide meaning of "touch.' It may be called *visual* but not visible.")[1]

Now there is no fundamental or necessary connection between the sensations attending the turning in of the eyes and greater or less distance. It is merely that an habitual or customary connection has grown up between these two sorts of ideas. So that the mind no sooner perceives the sensation arising from the different turning in of the eyes, than it immediately perceives the different idea of distances which it is accustomed to associate with that sensation. Similarly on hearing a certain sound, the idea which custom has united with it is immediately suggested to the mind.

From which it follows that the judgment we make of the distance of an object is entirely the result of experience. If we had not repeatedly associated certain sensations arising from different dispositions of the eyes, attending different degrees of distance, we would never be able to make sudden judgments of distance, any more than we could judge a man's thoughts by his pronouncing words which we have never heard before.

In dealing with one eye, if the object is brought very near, it becomes confused, in which case we associate a greater degree of confusion with proximity. It is true that we may prevent the

appearance of the object growing more confused by straining the eye, in which case the sensation of strain supplies the place of confused vision and aids the eye in its judgment.

In neither case, however, does the mind judge the distance by the greater or less divergence of the light rays, but depends upon the arbitrary signs of either confusion or strain.

From what has been stated, it follows that a man born blind, being made to see, would at first have no idea of distance by sight. The sun and stars, together with near objects would all seem to be in his eyes or rather in his mind. In fact all objects would seem to him as near as pain or pleasure or the innermost feeling of his soul.

If, as is commonly supposed, men judge distance by the angles of the optic axes, then a blind man gaining his sight would require no new experience to perceive distance by means of his vision.

Now it is agreed that colours are the immediate objects of sight and that they are inside the mind and not outside it. Yet what do we mean by the terms extension, shape and motion? If we consider the matter, we are forced to the conclusion that we cannot conceive extension without colour, nor can we conceive shape and motion without extension.

Suppose, for example, I am looking at the moon which I judge to be 240,000 miles away. I see a small round luminous flat, but it is quite clear that the real moon is nothing like that. If I was carried towards the moon, the visual impression would change so much on approach that the original impression would be entirely lost.

Again, suppose I see in the distance a faint outline of something which I take to be a man, tree, or tower and judge it to be a mile off. It is obvious that what I see is not a mile off, since every step I take alters my impression of it.

The truth of the matter is, that having for a long time experienced certain ideas such as distance, shape and solidity by touch and connected them with certain ideas of sight, I do, upon perceiving these ideas of sight, automatically conclude the tangible ideas which usually follow.

("This is the first distinct mention of 'touch' in the *Essay* a term which with Berkeley includes not merely the organic sense of simple *contact*, but also the sense of muscular resistance, and the sensations due to our locomotor activity. From this point he begins gradually to unfold the antithesis of the visible and the tangible worlds—of coloured and resistant extension. To explain by suggestion and habit the synthesis of these antithetical elements is the aim of his theory.")[2]

From what has been said, it follows that neither distance nor things placed at a distance are truly perceived by sight. They are no more perceived by the eye than they are by the ear.

Sitting in my study I hear a coach drive up the street, I look through the window and see it, then walk out and enter into it. In common language one speaks as if one heard, saw, and touched the same thing, namely, the coach. But in actual fact the ideas sent into the three senses are widely different and distinct from one another. It is only because they have been so often associated, that one imagines them to be one and the same thing.

It requires some thought to arrive at this conclusion, but if you examine the matter closely you will understand that you never hear, feel and see the same thing. What is seen is one thing, and what is felt or heard is another. This point is difficult to grasp because visible and tangible ideas are given the same name. The whole use and purpose of language makes this a necessity.

In order to understand accurately the process of vision, one must bear in mind that there are two sorts of objects—primary, and secondary. Primary visual objects are inside the mind. They can become big, small, faint or clear, but they cannot approach or recede from us. But when we speak of an object coming near or drawing away, we are referring to a secondary object. These objects are not so much seen by the eye as suggested to the eye in the same way as thoughts are perceived by the ear. To give an example: no sooner do we hear the words of a familiar language than we immediately think the thoughts that they represent and we act as if we heard the very thoughts themselves.

In the same manner, secondary objects, or those which are only suggested by sight, often impress us more strongly than the proper objects of sight along with which they enter into the mind and with which they have a far stricter connection than ideas with words.

The above in outline constitutes the first part of the theory. The remainder of the essay treats in a similar fashion our estimation of size. He explains that geometry deals with tangible extension and not visible extension, and the whole leads up to his theory of a divine visual language.

However, sufficient has been given to illustrate the trend of his arguments. It is outside the scope of the present paper to discuss any of the premises or arguments round which the theory is built, and the discussion which follows deals purely with the main conclusions.

Berkeley was an empiricist, the term implying that space perception is entirely learnt as against it being inherited or instinctive. He has also been described as a tactualist, which term suggests better his doctrine that touch is the space sense *par excellence*, and that sight in its primitive purity is devoid of all space character. Furthermore, he argues that sight and touch are two entirely

independent sources of information. Impressions received from one source cannot be appreciated in terms of the other, without their having been previously experienced in association. Colours are the only direct sensations which the eye can appreciate. Space means room to move about in. When one sees an object six feet away one judges this distance purely in the amount of locomotor activity which one would require to cover the ground in order to reach it. Previous education has taught us to associate our tactile experiences so intimately with certain visual signs that we imagine these visual signs give us first hand information of the extended world. The statement "I see distance" is, as Hollingworth[3] puts it, analogous to the statement "the water looks cold."

This was the doctrine introduced by Berkeley. The vista of speculation which it opened up formed a background for a controversy which involved many future generations of authorities on visual optics. They were divided roughly into two schools—the empiricists, of which Helmholtz and Wundt were notable examples, and the nativists which included Hering and Muller. The nativists believe in the inheritance theory and long are the arguments which raged round the well-known query which was put to Locke[4] in a letter from Molyneux. The question asked whether a man born blind being made to see would be able to distinguish a cube from a sphere although previously acquainted with them only with his hands?

The answer is one which should be decided by experiment, and Berkeley in his original essay quotes no evidence of this kind.

However, in the "theory of Visual Language Vindicated and Explained," published in 1733, he cites the famous operation of Cheselden.[5] The patient, a boy of fourteen, was suffering from dense congenital cataract which was successfully couched. "When he first saw, he was far from making any judgments about distances, that he thought all objects whatever touched his eyes." "He knew not the shape of anything nor of any one thing from an other."

Since then there have been a number of these cases on record, but they belong for the most part to the nineteenth century. More modern instances are rare, owing to the fact that such cases rarely escape being treated in early childhood.

But the reports as they stand are more or less in accordance with Cheselden's observations, and of Raehlmann's[6] case it is recorded that the patient failed to recognise familiar objects such as a cup, and on seeing a large bottle for the first time, thought it was a horse.

The following is quoted from a case given by Nunneley.[7] The patient, a highly intelligent boy aged nine, was acquainted with a sphere and a cube, prior to his operation. After the operation

he was confined to a dark room. After keeping him in a dark room for a few days, until the opaque particles of his lenses were nearly absorbed, and the eyes clear, the same objects which had been carefully kept from him, were again presented to his notice. He could at once perceive a difference in their shape though he could not in the least say which was the cube and which was the sphere. "He said everything touched his eyes, and walked most carefully about, with his hands held out before him, to prevent things hurting his eyes by touching them."

The account of Franz's[8] case strikes a different note. The patient, a youth of eighteen, could distinguish bright colours before he was operated on, but he had no form sense. After his operation he was able to distinguish between the position of a vertical and a horizontal line. He could also determine a circle, a square, and a triangle, and name them as such, saying that he could only do so when he imagined the tips of his fingers feeling the objects. Solid objects he judged to be flat, and he could not distinguish between an object floating on the top of a glass of water and one at the bottom. The human face appeared to him as in one plane.

The case described by Latta[9] in which a thirty years old patient of Dr. Maitland Ramsay was able to distinguish the shape of a ball and a toy brick, is weakened, as the account points out, by the fact, that prior to the experiment, he may have picked up a little visual knowledge of shape from other objects.

Fisher's[10] case, which is the most recent account the writer has read, is disappointing as the details given are too meagre. Here it is reported that a girl in her seventh year was operated on in St. Thomas's Hospital. Being afterwards tested she failed to describe a penny and named a pair of scissors as a piece of glass.

On first reading these cases it would seem that the experimental evidence afforded by them was in favour of the tactualists' point of view. This was the opinion held by Clarke Murray[11] and others, but there are serious objections.

In the first place, a person recovering from such an eye operation is at a considerable disadvantage. He is probably in some degree of pain, his visual activity is low and he is dazed by the light and the novelty of the experience.

As Stratton[12] points out, many people with normal sight fail to recognise objects in a bad light, or in unfamiliar surroundings, or in unusual positions. Stratton suggests a forceful illustration of the problem. Suppose someone in a dark room is groping about for a cup, and his hand passes over one, which although ordinary in shape, is made of ice or butter. The probability is that the individual would be so impressed with the slithery feel of the article that he would fail to recognise it as a cup.

Would not this situation be analogous in some respects to that in which Raehlmann's patient found himself on being visually confronted with a cup for the first time? There is no doubt that he, in common with the other patients, did fail the tests, but the point is that the tests do not prove that they failed for the reasons Berkeley advances. For the tactualists would have it that visual conceptions of size and shape were absolute novelties to the patients, and the tests do not prove this.

It would appear as if the investigators expected too much, and were not concerned with primitive vision but devised tests which anticipated the vision in a partially developed state. It is now universally admitted that accurate perception of distance can only be learnt. But has it been established that we have no innate capacity for visual space perception like the one we have for colour or brightness? Can it be that experience merely organizes our judgments inside a spacial frame which is inherent at birth?

These are the questions at issue.

The fact that the patients detected a difference in shape although unable to name it, would indicate some inherent form sense, the existence of which the tactualists would not be prepared to admit. The fact that some of them said the objects touched their eyes might be their way of expressing that they were dazzled by the light.

Then there is Dr. Franz's case which appears to refute Berkeley's arguments. The account given is reasonably full and the tests appear to have been scientifically conducted. However, there is one point on which we would like to be better satisfied. How much light sense did the patient have prior to the operation? It is recorded that he could distinguish certain bright coloured lights. He also thought he could distinguish the shape of very strongly illuminated patterns, but this Dr. Franz assures us, was a mere illusion.

The point raised here is one which bears on a number of congenital cataract cures: namely, that they are not completely blind. They can usually distinguish strong light from darkness if nothing else. Parsons[13] states that they can often project light impressions and can also, if sufficiently intelligent, project phosgenes caused by pressure on the eyeball; so that we can conclude that this could give them some visual experience of space prior to their operation. Moved by these considerations, we cannot accept the reports of these operations as evidence that Berkeley was wrong. Although for reasons previously stated, we cannot conclude from the evidence that Berkeley was right.

Before considering any different types of experiments, let us examine some alternative theories on space perception.

What has been described as the visualist theory was advanced by Platner and supported to some extent by Hamilton.[14]

As opposed to the tactualists, the visualists maintained that sight alone gives us a knowledge of space and that the congenitally blind live in a purely time world. There are few facts to support this view. On the contrary, Saunderson has shown us how the blind can understand geometry.

Like the tactualists, the visualists have a one-sided doctrine, although it is one which is more easy to dispose of.

Then there is the opinion that both sight and touch give us first hand information of the world of space. Granting that this is so, it remains to be demonstrated whether it is congenital or acquired. If it can be shown that the sense of sight can appreciate space instinctively then Berkeley's theory is untenable.

It is not to be expected that this instinctive visual perception of space is very great. It may be that because it is so small in its undeveloped state that the empiricists have concluded that it does not exist at all. That it does exist in lower animals has been conclusively proved. It must often have been observed that chicks peck with extraordinary accuracy almost as soon as they are out of the shell, and this fact has been scientifically established. Vernon Grant[15] quotes the experiments of Lashley and Russell on the visual perception of rats.

A group of these rodents was reared in darkness for a hundred days. After which, the experiment consisted in making the hungry animals leap from a platform to another one in order to obtain food. The first platform was specially prepared in order to measure the force of the leap in grams, the reason being that the force behind each leap would vary with the distance away from the second platform. The stage was set with the food 20 cms. away and in the first attempt, all the rats overshot the mark, but rapidly improved. Next the food was moved 40 cms. away. This time ten out of the thirteen rats jumped with greater force than was required for the 20 cms. range. The average force exerted for the last five trials at 20 cms. being 6·8 grams, while that for the first jump at 40 cms. was 15·4 grams. The important point is that although few were able to reach the food platform at a first attempt, the greater distance immediately called for a stronger leap.

In the next test the rats' performance was nearly as good as that of a control group reared under ordinary conditions. Variations in force were noted for distances of under 2 cms. Grant states that here an inborn judgment for distance has been demonstrated but declines to draw any conclusions concerning human vision.

However, from these and other similar experiments, we must admit the possibility, if not the probability, of a similar innate organisation existing in man.

From observations on infants, it has been shown that they can fixate monocularly almost as soon as they are born, but more in this connection cannot be declared for certain.

In general, therefore, we sum up the existing evidence by stating it to be inconclusive and not deciding our problem one way or the other.

William James[16] was opposed to the Berkeleyan theory, and held the opinion that space and voluminousness were inherent in all sensations. Parsons[17] on the other hand holds that visual space perception, so far as magnitude is concerned, presupposes tactile or haptic perception.

Duke-Elder[18] concludes that the most reasonable interpretation of the observed phenomena seems to take in both points of view. He sums up in stating that the conception of space is built up on an innate but plastic basis which is modified by experience. Just where the differentiation between the two processes takes place, is, he considers, largely a matter of individual opinion. He holds a fairly strong brief for pushing the empiricists' view on the grounds that it is the one which is more stimulating to research.

Contemporary psychologists do not debate the issue. As Vernon[19] puts it "As in all our perceptions, objective stimulus conditions and subjective conditions in the individual are combined and organized to form a basis for our perceptions of space, and our ability to estimate and judge extent." What appears to them to be more important, is to investigate the relationship between the various perceptual patterns which subserve space perception.

Appendix

The experiments of Stratton threw some interesting light on the spacial relationship between sight and touch. In practice we see an object where we touch it. For example, an article touching the skin is seen lying against it, whilst one at arm's length is seen about two feet away, etc.

The question raised is whether there is any point in the visual field where we can say we *should* see something we happen to be touching. Was there a time when such experiences were unconnected? Was there a time when the visual sensation of an object and the pressure on the hand that grasped it were not localized at the same point in space?

The experiment where Stratton wore an inverting lens system until his mind learnt to compensate for it, is well known.† But his more elaborate and no less interesting experiment with mirrors is not frequently referred to. The following is a brief account.*

† Details given in the *Psychological Review*, Vols. III and IV.

* For full account see "The Special Harmony of Sight and Touch," *Mind*, October, 1899.

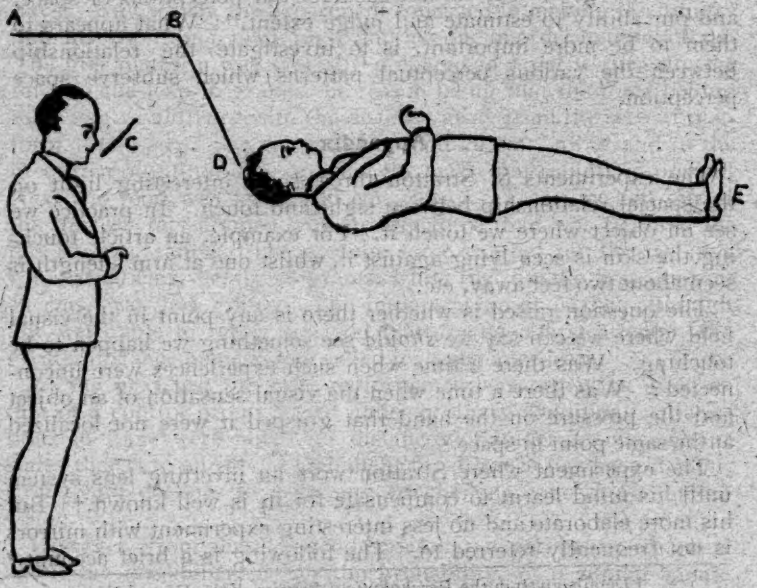
He attached to himself a pair of mirrors by means of a light frame, so that he observed himself from a point above his own head.

In the diagram, AB represents a horizontal plane mirror while C is a smaller mirror fixed at an angle of 45 degrees. BD is a dark cloth screen which was fastened round sufficient of AB to exclude any peripheral vision. DE is the image of the observer. The arrangement enabled him to see the whole of his body plus a small radius round about it.

On the first day the apparatus was worn from 3.20 p.m. to 9.30 p.m.: on the second day from 9.0 a.m. to 7.30 p.m., and on the third day from 9.45 a.m. to 5.15 p.m. In between times the eyes were securely blindfolded.

Naturally to begin with there was constant rivalry between the spacial reports of the two senses. The body and limbs were seen at different places from where they were felt. Not only were the visual images out of direction, but they were also at misleading distances, so that the whole co-ordination between sight and touch were disrupted.

However, on the third day Stratton reports that he was beginning to get used to the situation, and there were occasions when he felt his body in the same place where he saw it. By the end



Stratton's mirror device for showing the body in a false direction and distance.

of the third day he had experimented sufficiently to be convinced that we have only to see a thing for long enough in a given place to imagine we feel it there also. He concludes that if we had been so constructed that we always saw our bodies a hundred yards away we would feel them there also. In fact a spacial harmony between the two senses can grow up under a vast variety of conditions, provided that the experience be sufficiently uniform. From his results, it appears likely that normal reactions are developed in a similar way. But this fact does not alter the conclusions arrived at in the paper.

One must be cautious about applying conclusions drawn from an experiment dealing with reactions, to a problem dealing with origins.

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THE EFFECT OF THE DURATION OF STIMULUS ON THRESHOLD MEASUREMENTS IN THE DARK ADAPTED EYE*

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Introduction

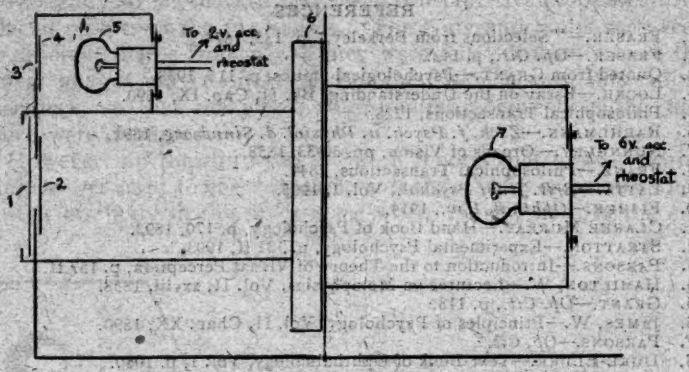
INSTRUMENTS used for the determination of dark adapted rod thresholds incorporate a test light which is either continuously illuminated (Craik & Vernon, 1941, S. Yudkin, 1941) or exposed as a flash of definite duration. The duration of flash used in the latter type of instrument varies, however; for example, Wald and

* Received for publication, August 22, 1944.

Steven (1939) use exposures of 0·02 second, Hecht and Schlaer (1938), exposures of 0·2 second, and Stiles (1943), exposures of 0·8 second. The instrument designed for use in the Royal Air Force incorporates a camera shutter the speed of which can be varied, and in 1942 the effect of variation in the duration of exposure was studied.

Methods and Procedure

The test light of the instrument (see Fig.) is an opal disc ½ inch in diameter illuminated from behind by a 6 volt 3 watt bulb activated by accumulators. The brightness is reduced to the order of that required by the dark adapted eye by a dense "neutral"



ROYAL AIR FORCE ADAPTOMETER.

1. "Neutral" Filter } covering opening of test patch.
2. Opal Glass Plate }
3. Fixation spot.
4. Dark red Wratten filter.
5. 2v. 1·5 watt lamp for fixation spot.
6. Camera shutter.
7. 6v. 3 watt lamp for test light.

filter (transmission 0·069 per cent.) placed in front of the opal disc. It is then varied over the necessary range by a graduated rheostat which, with a voltmeter, is connected in the circuit. Only small movements of the rheostat are required and the colour of the test light remains practically constant. A camera shutter is interposed between the bulb and the opal disc so that the test light can be exposed for different durations. A small fixation spot of dim red light is placed 1½ inches above the centre of the test light and is illuminated by a separate bulb and circuit. It is kept at just visible brightness during the test by a rheostat in the circuit. The fixation spot and test light are viewed through a tube 12

inches long fixed to the front of the instrument. The area of retina thus tested is of visual angle 2·3° and the centre is 7° above the macula.

The test is carried out as follows. Five subjects are instructed to wear goggles fitted with dark-green glass of transmission about 4 per cent. and are kept in a dimly lighted room for 20-25 minutes. They are then taken to the dark room where they remain for a further 25 minutes. During this time a short explanation of the procedure of the test is given. The first subject then sits at the instrument and views the fixation spot with both eyes open. The test light is adjusted to a fairly high brightness and one or two exposures made. It is then flashed on at intervals of about 4 seconds, and the subject states " seen " or " not seen " for each flash. A short rest is allowed after about every twenty exposures. The brightness of the test light is gradually reduced until one flash is " not seen "; it is then gradually increased until a flash is " seen " and once more reduced in small steps until three consecutive negative responses are obtained at one level of brightness. The reading on the graduated rheostat is recorded. The other four subjects follow, and then all are tested again. The mean of the two readings for each subject is regarded as the final rod threshold for that individual.

The experiment was carried out on about 600 airmen at an R.A.F. Station in England. The dark adapted rod thresholds of these men were measured on each of three occasions at intervals of three weeks. On each occasion the threshold of each man was measured using two different periods of exposure. One of these was 0·2 second, the other was 0·02, 0·04, 0·1, 0·5 or 1 second, the same two exposures being used for each man for all three tests. Thus all the men were tested with the 0·2 second exposures and about 60-115 men with each of the other exposures. Some of the men were not available for all three tests and some were tested only with the 0·2 second exposure.

During the intervals between the tests the men received various vitamin or dummy tablets. No specific effect on the thresholds was produced by any of these supplements, however*, and the results for each exposure time may thus be considered independently of the treatment given.

Results

Table I shows the mean threshold values and standard deviations for the different durations of exposure of the test light. For each exposure the mean and standard deviation of the thresholds of the same men tested with a 0·2 second exposure is also given.

* There was a slight but significant improvement in all groups, due apparently to a " learning " effect (see also Tables II and III) but no difference between the groups receiving different supplements.

It is seen that the mean threshold is lower with the longer durations but the change is not proportional to the increase in duration. Between the 0·5 and 1 second exposures, indeed, there is no further lowering of the threshold. The range of the threshold values of the groups tested with each duration does not differ significantly and is about one log unit.

The thresholds of most of the men varied somewhat from test to test. The amount of variation, unlike the range of the thresholds, differed according to the duration of exposure of the test light (Tables II and III). This variation is least for the 0·2 second exposures for both the 1st-2nd and 2nd-3rd tests although many of the differences are not significant. The results for all the tests

TABLE I.—*Rod Thresholds for Different Durations of Exposure of Test Light*

Duration of flash (seconds) ...	0·02	0·2	0·04	0·2	0·1	0·2	0·5	0·2	1	0·2
Number tested	115	115	109	109	107	107	122	122	88	88
Mean threshold in log $\mu\mu$l ...	4·284	3·577	3·956	3·615	3·818	3·639	3·415	3·549	3·452	3·580
Standard Deviation	·129	·141	·173	·145	·158	·165	·165	·154	·151	·140
Difference between S.Ds.	·012 ± ·013		·027 ± ·015		·007 ± ·016		·011 ± ·014		·011 ± ·016	

TABLE II.—*Changes in Thresholds Between 1st and 2nd Tests*

Duration of flash (seconds) ...	0·02	0·2	0·04	0·2	0·1	0·2	0·5	0·2	1	0·2
Number tested	115	115	62	62	68	68	114	114	83	83
Mean change log $\mu\mu$l	−·0152	−·0052	−·0416	−·0312	−·0214	−·0258	+·0265	+·0204	−·0170	+·0010
Standard Deviation	·150	·126	·172	·140	·162	·133	·149	·121	·133	·132
Difference between S.Ds.	·024 ± ·013		·032 ± ·020		·029 ± ·017		·028 ± ·013		·001 ± ·015	
Difference between S.Ds. (using all 0·2 second together) (S.D. = ·128)	·022 ± ·011		·044 ± ·016		·034 ± ·015		·021 ± ·011		·005 ± ·011	

TABLE III.—*Changes in Thresholds Between 2nd and 3rd Tests*

Duration of flash (seconds) ...	0·02	0·2	0·04	0·2	0·1	0·2	0·5	0·2	1	0·2
Number tested	64	64	59	59	84	84	108	108	91	91
Mean change log $\mu\mu$l	−·1584	−·0392	+·0190	−·0070	+·0306	−·0212	+·0101	+·0083	−·0139	−·0265
Standard Deviation	·133	·106	·137	·096	·114	·104	·108	·096	·129	·109
Difference between S.Ds.	·027 ± ·015		·041 ± ·018		·010 ± ·012		·012 ± ·010		·020 ± ·013	
Difference between S.Ds. (using all 0·2 second together) (S D. = ·103)	·030 ± ·012		·034 ± ·013		·011 ± ·010		·005 ± ·008		·026 ± ·010	

with the 0·2 second exposure may be combined as they are very similar and then the differences between the 0·2 second and most of the other exposures become statistically significant. It may be noted that the changes between the 2nd-3rd tests are less for all durations than those between the 1st and 2nd; this is probably due to a "learning" factor.

Discussion

a. Relationship of mean threshold to duration of exposure.—The relationship between the duration of stimulus and threshold levels depends in part on the size of the test field (Graham and Margaria, 1935). With very small parafoveal fields the threshold varies inversely as the duration of stimulus over a certain range; as the durations become longer there is a fairly abrupt change so that the threshold hardly changes with increasing duration. When larger fields are used the abrupt change does not occur; instead the threshold decreases continuously, but not proportionally, with increasing duration.

The results given here are in broad agreement with those of Graham and Margaria for the larger test fields. These authors explain the absence of the abrupt change as due to an increasing proportion of neurones with only partial overlap from other stimulated neurones as the field becomes larger, with incomplete summation in these neurones. Another consideration seems equally important, however. The maximum length of time for which the eye can remain fixated is probably about 0·2 seconds. When the test light is exposed for 1 second, say, it may be fixated

for 1, 2 or 3 periods of 0·2 seconds. Now, Hecht, Schlaer and Pirenne (1942) have re-emphasised (see also Stiles, 1939) that at brightnesses near the threshold level there is no definite brightness above which the test light is always seen and below which it is never seen but a gradually increasing proportion of negative responses as the brightness is reduced. With an exposure longer than 0·2 seconds, therefore, the light may in effect be exposed more than once and if even one of these exposures is seen, a positive answer will be given. The proportion of positive responses will thus tend to be greater than when 0·2 second exposures are used and the threshold measured as described above will tend to be lower with the 0·5 or 1 second exposure than with the 0·2 second exposure.

Again, the reaction time of the eye is about 0·2 seconds (Duke-Elder, 1938) so that with stimuli of longer duration than this there is time for fixation to be lost and for a different and possibly more sensitive part of the retina to be stimulated. This also would tend to lower the threshold with longer durations.

b. Range of thresholds in groups of subjects tested with different durations of exposure.—The range of thresholds seems to be a characteristic of the population and not to depend on the exact method of measurement (see also Hecht and Mandelbaum, 1939). It is similar when a continuously illuminated test light is used (Yudkin, Robertson and Yudkin, 1943). This means, in effect, that when individual readings are less important than the mean value and standard deviation of the thresholds of a population as a whole (*e.g.*, in nutrition surveys) any consistent duration of exposure may be used.

c. Variability of individual thresholds with different durations of exposure.—The considerations concerning the fixation and reaction times of the eye help also to explain the greater variability of the thresholds with exposures longer than 0·2 seconds. As the light may be seen one or more times with these longer exposures and as different parts of the retina may be stimulated during the exposure the apparent threshold will be likely to vary a good deal from test to test.

With the exposures shorter than 0·2 seconds the red light may not be fixated at all during the exposure and different portions of the retina may be stimulated with each flash. In addition slight variations in the speed of the shutter affect threshold levels markedly when the exposures are short but very little when they are longer than 0·2 seconds (Graham and Margaria *loc. cit.*, and Table I). As the shutter used in this experiment was an ordinary camera shutter these variations in speed may have accounted in part for the greater variability of the thresholds with the 0·04 and 0·02 second exposures.

With the 0·2 second exposure the light may be seen for all or part of that time; there is no time for the wrong portion of the retina to be stimulated, however, and slight differences in the exposure time are of little consequence at this duration, so that inaccuracies of the shutter will not be important. It would seem then that on both theoretical and practical grounds 0·2 seconds is the most suitable duration of exposure of the test light for repeated measurements of the dark adapted rod thresholds.

Summary and Conclusions

Five groups of 60-115 men were tested on each of three occasions. The dark adapted rod thresholds of all the men were measured using a test light exposed in flashes of 0·2 second duration. In addition the thresholds of the men in each of the groups were tested with a test light exposed in flashes of one of the following durations: 0·02, 0·04, 0·1, 0·5 or 1 second.

The following results were obtained.

1. The mean threshold was lower for the longer durations up to 0·5 seconds but the lowering of threshold was not proportional to the increased duration of exposure.
2. The range of thresholds for all the groups was the same whatever the exposure.
3. The variability of individual thresholds from test to test was least with the 0·2 second exposure and more for all the other exposures.

The results given here are probably applicable to all measurements of threshold values made with similar instruments.

Acknowledgments.—I am indebted to Dr. Bradford Hill for help with the statistical analysis of the results and to the Commanding Officer, officers and men of the Station who assisted in the arrangements or took part in the tests.

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BILATERAL PARTIAL ECTASIA OF THE NERVE HEAD WITH PERIPAPILLARY ECTASIA*

BY

IAN S. MACGREGOR

GLASGOW

GROSS cupping of the disc which is not glaucomatous, associated with a wide scleral halo, or ring, and pigmentary disturbance has been described several times in the literature. It may be unilateral or bilateral. The visual acuity may be much or little reduced and the field restricted or normal. Where it is unilateral the fellow eye may be quite normal. The cup may contain a fine film of bluish-grey tissue. The appearances have been regarded by the authors as of congenital origin.

Hancock describes such a deep cup in a girl of eleven years with vision of 6/36 improving to 6/18 with −1·5 D. cyl. The other eye was quite normal. The cup was 14·0 D. deep and showed a fine bluish film. There was a wide pigmented halo but the picture indicates that the pigmentary disturbance was not marked. The field was difficult to chart but was probably normal. Roenne describes bilateral deep excavation in the cups of a woman of thirty-nine years with no glaucomatous symptoms. There had been a difficult forceps delivery and there was facial asymmetry. No abnormality in the other members of the family was found. There was a wide halo heavily pigmented at its outer border. In one eye the cup showed a thin bluish film. He quotes Zade and Stock and von Szily (1906) who reported similar cases. Roenne's case is described in an article on congenital anomalies. The right eye was divergent and almost blind, the left eye was myopic and amblyopic. He calls it pseudo-glaucomatous cupping of the disc, Kraupa describes a similar picture in one eye where the cup was 20·0 D. deep and vision very deficient. The excavation appeared shelved and evoked the description " Terassenförmig aufgebautes opticus coloboma." Young describes the condition of gross cupping without glaucoma in a woman, aged sixty-two years, in one eye. The other eye was normal. She squinted as a child. The tension in both eyes was normal. Vision in the affected eye which was emmetropic was 6/36, and unimproved. The cup was 5-7 mm. deep. Young thought it was quite unlike the ectasia seen in microphthalmos, or myopia. He thought it was a congenital anomaly " in the sense of malformation in the evolution of the primary optic vesicle." Q. Di Marzio in his atlas describes under the heading of congenital anomaly, non-glaucomatous

* Received for publication, July 10, 1944.

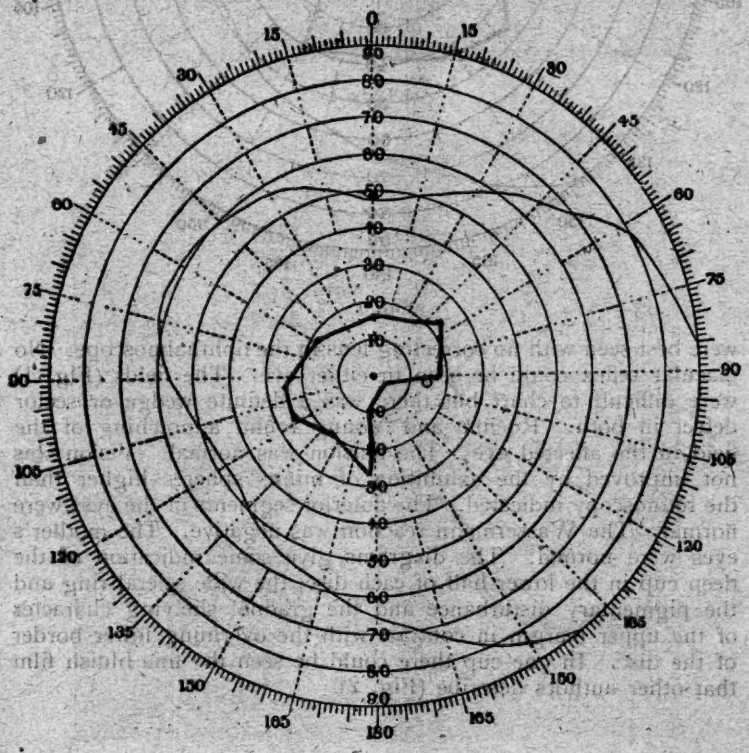
excavation of the disc with halo and pigmentary disturbance (*His, Fig. 18*) *in a patient of thirty years* with tension normal and field normal. Vision in the affected eye was 8/10. The fellow eye was normal. *In another case (Fig. 17)* he describes partial coloboma. One side of the disc was deeply cupped and the other side was normal. *There was a scleral ring* and pigmentation on the side which was excavated.

The case now to be described has partial bilateral excavation of the disc below with complete wide halo and gross pigmentary disturbance. M. McV., aged seven years, well developed and healthy second child; easy delivery. Vision, R. and L., 6/36. Right eye improved to 6/18 with +0·50 D.S. and −2·0 D.C. at 180 degrees. Left eye not improved.

Retinoscopy shadows. $\frac{+2\cdot0}{-2\cdot0}$ $\frac{+0\cdot5}{-5\cdot0}$

The margins of the disc were best seen with −6·0 D. and the floor of each cup with −18·0 D. The central fundus and periphery

RIGHT.



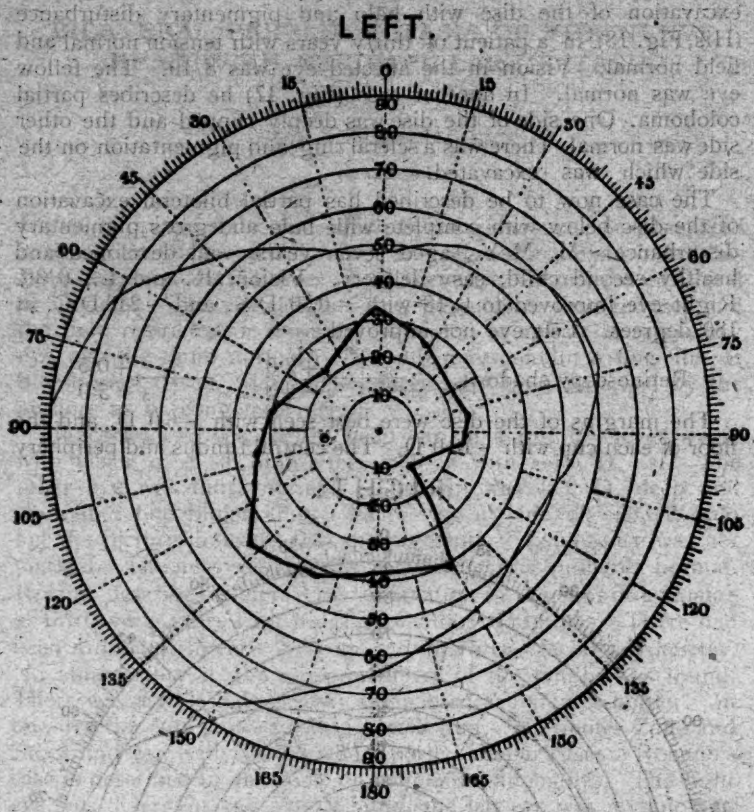
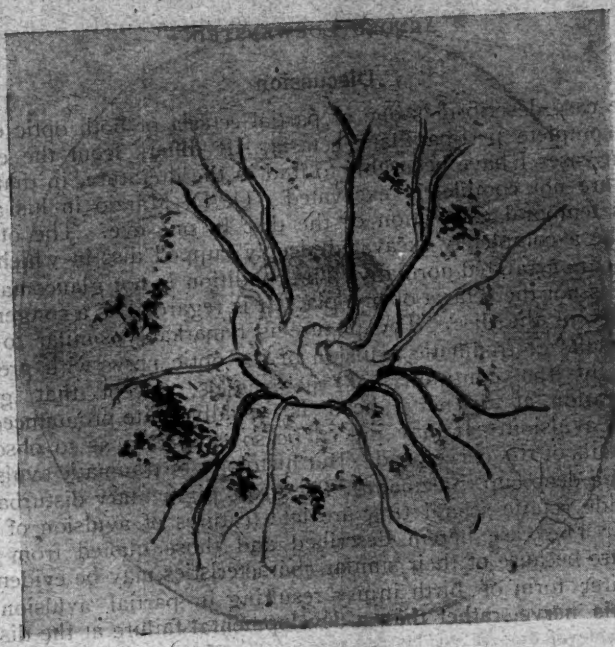
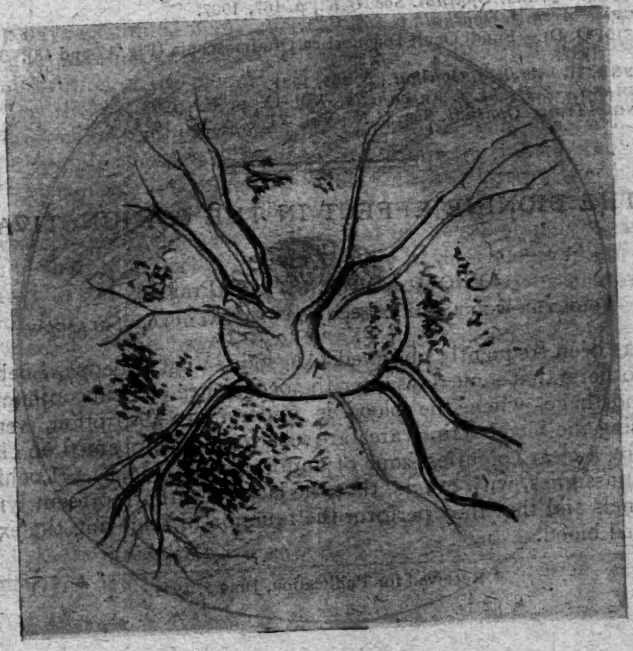


FIG. 1.

were best seen with no correcting lens in the ophthalmoscope. No macular reflex could be seen in either eye. The fields (Fig. 1) were difficult to chart but there was a definite wedge or sector defect in both. Roenne and Young found a notching of the field in the affected eye. The tension was normal. Vision was not improved by the exhibition of minus spheres higher than the retinoscopy indicated. The anterior segments of the eyes were normal. The Wassermann reaction was negative. The mother's eyes were normal. The diagrams give some indication of the deep cup in the lower half of each disc, the wide scleral ring and the pigmentary disturbance and the gradual shelving character of the upper margin in contrast with the overhung lower border of the disc. In one cup there could be seen the fine bluish film that other authors describe (Fig. 2).



Right Eye.



Left Eye.

FIG. 2.

Discussion

The case described is one of partial ectasia of both optic discs with complete peri-papillary ectasia. It differs from the other similar cases I have been able to find in the literature, in that the discs are not completely excavated. Q. Di Marzio in his atlas shows temporal excavation of the disc in one eye. The others describe a completely excavated, deeply cupped disc in which the vessels are arranged normally. The condition is not glaucomatous and it is not the ectasia of myopia. It is regarded as a congenital anomaly of the disc. The picture is remarkably similar to the late results of traumatic avulsion of the optic nerve with preservation of the continuity of the vessels, except that glial proliferation at the nerve head is usually quite pronounced in proven avulsion. It may indeed be so exuberant as to obscure the details of the nerve head. But histology of traumatic avulsion reveals a deep cup (Salzmann). The gross pigmentary disturbance and wide ectatic scleral ring are late features of avulsion of the nerve. The case herein described and those quoted from the literature because of their similar characteristics may be evidences of a rarer form of birth injury resulting in partial avulsion of the optic nerve, rather than a developmental failure at the disc.

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THE DIONINE EFFECT IN THE CONJUNCTIVA*

BY

ARNOLD LOEWENSTEIN (Prague)

FROM THE TENNENT INSTITUTE FOR OPHTHALMOLOGY, GLASGOW

IT has been frequently observed (Augstein, Vogt, Koeppe, Loehlein and others) that some days after the occurrence of a subconjunctival haemorrhage, when the blood is undergoing absorption, vessels crossing the blood-stained area are seen to be accompanied on either side by a clear colourless zone of uniform width (Fig. 1). (Loehlein, 1928) assumes, with others, that the clear sheaths represent lymph channels and that they perform the function of removing the extravasated blood.

* Received for Publication, June 5, 1944.

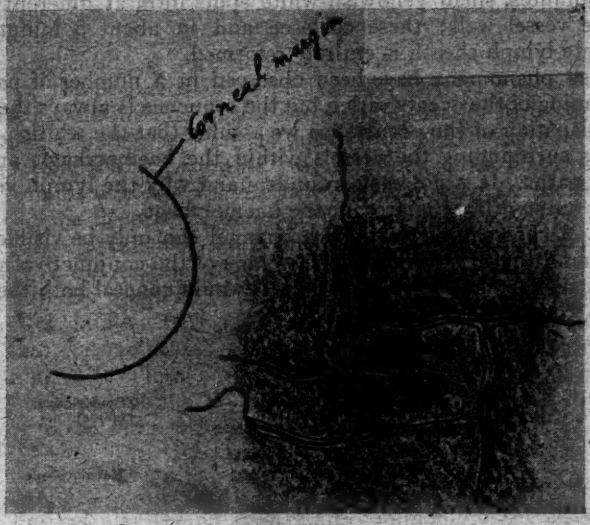

FIG. 1.

Subconjunctival haemorrhage. Nine year old boy, seventh day, blunt injury. The white sheathings are restricted to haemorrhagic area.

We have examined many subconjunctival haemorrhages with the binocular microscope and slit-lamp and have followed the process of reabsorption of the blood. The cases were of various types; but whether the patients were young or old, and the haemorrhages spontaneous or traumatic, the same phenomena were observed.

The lymph channels were seen best from the fourth day after their appearance, and remained visible until the last trace of haemorrhage had disappeared. The width of the sheath on each side of the vessel is approximately equal to that of the blood column, and it is quite sharply defined. It is found only in vessels of medium size, situated in the middle layers of the subconjunctival tissues, and is strictly limited to the area of the haemorrhage. Sometimes, beyond the margin of the haemorrhage, the vessel was accompanied by a faint haze, which might belong to the wall of the vessel; but had no resemblance to the sharply defined lymph channel. Perhaps improvement in the optical conditions might succeed in revealing the presence of the sheath beyond the haemorrhagic area.

It is of special interest that the lymph sheath disappears after the instillation of 2 to 5 per cent. dionine solution into the conjunctival sac. This occurs in from 40 to 80 seconds after the application, and is not quite simultaneous throughout the length of the vessel. Similarly, when the oedema passes away, which it does in from 30

to 60 minutes, small yellowish-white spots form at different points on the vessel wall; these coalesce and in about 5 minutes the complete lymph sheath is entirely reformed.

These phenomena have been observed in a number of patients. The timing of the events varies, but the sequence is always the same. In explanation of the occurrence we assume that the whitish-yellow sheaths surrounding the vessels within the haemorrhagic area are lymph paths. It is not easy to understand why the lymph vessel is visible only within the area of the haemorrhage.

Fig. 2 shows that the lymph channel can only be visible when the haemorrhage is *confined to the plane* of the conjunctival *vessels*. If the haemorrhage were superficial it would conceal both the blood

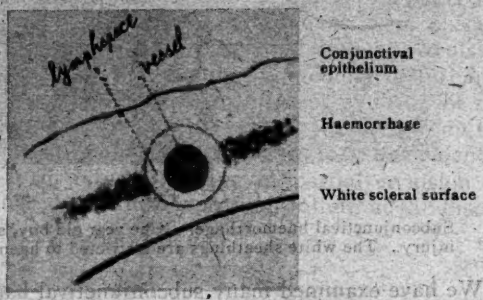

FIG. 2.

Schematic explanation of the clinical appearance.

column and the lymph sheath: if it were deeper it would form a dark background to the vessels and obscure the white sclera which is essential to render the transparent lymph space visible.

Dionine dilates the conjunctival blood vessels, and this may account for the disappearance of the lymph channels, which refill as the oedema passes off. In addition the oedema which gradually rises, moves the blood layer out of position and renders it diffuse. As a result the conditions of visibility of the lymph spaces are no longer present. Using the narrow beam of the slit-lamp, and with the higher magnifications of the corneal microscope, it can be seen that for ten to fifteen minutes the oedematous fluid is clear. It then becomes hazy and finally milky, and this persists until the oedema disappears. Presumably the cloudiness of the fluid is due to the migration of leucocytes from the blood stream.

We have occasionally observed, within the haemorrhagic area, isolated lymph vessels, not visibly connected with the blood vessels, and once a clear pearly vacuole was seen. It may be of some

significance that neither of these appearances was influenced in any way by the dionine application.

The application of adrenalin has not been observed to cause any change in the perivascular lymph spaces.

Variations in the intensity of the dionine reactions are interesting. We found it particularly strong in children, weaker in older people, and in arterio-sclerotic subjects. An arterio-sclerotic man with glaucoma simplex was especially refractory. Alajmo found the conjunctival oedema especially pronounced in scrophulous children. It may be that a scale of vascular function might be established on the intensity of the dionine effect.

The rabbit's conjunctiva is not responsive. Even a 5 per cent. solution of dionine does not produce chemosis, but this does not prove that dionine has no effect on the rabbit's eye. Loewenstein and Kubik (1915) found that the application of dionine powder to the rabbit's conjunctiva caused a rise (slight, but beyond the limits of error) in the refractive index of the aqueous humour.

Summary

1. Perivascular lymph vessels are commonly observed in cases of subconjunctival haemorrhage four or five days after its occurrence. They can be seen to accompany conjunctival vessels which cross the haemorrhagic area. An optical explanation is offered.

2. They disappear in from 40 to 60 seconds after instillation of dionine solution, concurrently with the onset of conjunctival oedema, and reappear in from 30 to 60 minutes as the oedema passes off.

3. The oedematous fluid in the conjunctiva, at first clear, becomes milky after 15 to 30 minutes.

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BURIED SILK, CATGUT AND STRABISMUS SUTURES*

BY

JOHN FOSTER

LEEDS

IN view of the terminal remarks in the annotation in May, 1944, p. 249, I thought that the following clinical and experimental findings might be of interest,

* Received for publication, June 30, 1944.

Having used both silk and catgut for buried strabismus sutures, I have not noticed much difference either in the reaction, or the firmness of the junction so produced.

Single recessions can return home in a week as a rule, while Dunnington[1] using 0000 10-day chromic catgut even sends patients home in 48-72 hours.

When reaction has been marked, there has usually been collateral evidence of infection, haematoma, or high muscular tension, produced by a large resection.

Whether silk or catgut is employed, a certain amount of stretching appears to take place in a few cases in the first few weeks after operation, and some orthoptists are most anxious to restart as soon as possible after any operation ending in an under-correction.

Chromicised 30-day 6/0 (000) catgut mersutures were employed exclusively in the cases recorded in my paper[2], as in general I was following the technique of Jameson[3]. In addition to this, when used as a conjunctival suture, catgut absorbs spontaneously, and need neither be removed therefrom in children, nor from the deeper layers if infection occurs.

Much greater care is needed in procuring apposition of the conjunctival edges, to avoid granulations, than when 00 black silk is employed.

Strength of Sutures

In 1939 I noticed (when writing the paper quoted above), that No. 2 white silk (the usual squint advancement suture) seemed unnecessarily thick and strong, and that on one or two occasions twice-boiled black 00 silk disintegrated almost spontaneously. I therefore asked Professor Speakman of the Textile Department of Leeds University to determine the tensile strength of various forms of ophthalmic silk in current use, to ascertain the effects of different methods of sterilisation, and of dyeing upon it[4].

His figures for the "straight-pull" breaking load, are given in Table I. These show that the length of sterilisation up to six minutes has little effect on silk, but that silk sterilised in 2 per cent. sodium bicarbonate solution is only 97·7 per cent. as strong as when sterilised in distilled water.

Black threads, on the whole, are weaker than white of the same diameter. This finding is true of all dyes, though some are worse than others. It is interesting to note that English ophthalmic silk is no longer "iron dyed" (Logwood with an iron mordant) as stated on the packet. Since 1935 sometimes sulphur black has been found more satisfactory.

If the gauges are comparable with Localio's[7] figures, then it would seem that cotton is stronger than ophthalmic silk of the same diameter.

TABLE I

Strength Tests of Silk Threads: Tested 9 inches between jaws

Sample No.	Unboiled	Boiled in Distilled Water		Average	Boiled in 2 per cent. Soda Bicarbonate Solution		Average
		3 minutes	6 minutes		3 minutes	6 minutes	
Black 00 (twisted)	21·5 oz.	19·5 oz.	19·5 oz.	19·5 oz.	20·0 oz.	—	20·0 oz.
Black 0 (twisted)...	29·0 oz.	28·5 oz.	28·0 oz.	28·25 oz.	28·0 oz.	26·5 oz.	27·25 oz.
Black 1 (braided)	47·0 oz.	47·0 oz.	45·5 oz.	46·25 oz.	44·5 oz.	45·0 oz.	44·75 oz.
Black 2 (braided)	no test	112·0 oz.	113·6 oz.	112·8 oz.	113·6 oz.	100·0 oz.	106·8 oz.
White 00 (twisted)	28·0 oz.	28·0 oz.	26·5 oz.	27·25 oz.	26·0 oz.	26·5 oz.	26·25 oz.
White 0 (twisted)...	39·0 oz.	41·0 oz.	38·0 oz.	39·5 oz.	39·0 oz.	37·0 oz.	38·0 oz.
White 1 (braided)	44·0 oz.	45·0 oz.	44·0 oz.	44·5 oz.	44·5 oz.	43·5 oz.	44·0 oz.
White 2 (braided)	80·0 oz.	83·2 oz.	80·0 oz.	81·6 oz.	80·0 oz.	83·2 oz.	81·6 oz.
ELONGATION TESTS							
Black 00	2·19 in.	2·69 in.	2·69 in.	2·69 in.	2·19 in.	—	2·19 in.
Black 0	2·44 in.	2·44 in.	2·44 in.	2·44 in.	2·38 in.	2·25 in.	2·315 in.
Black 1	2·56 in.	2·94 in.	2·63 in.	2·785 in.	2·63 in.	2·75 in.	2·69 in.
Black 2	—	2·70 in.	2·70 in.	2·70 in.	2·90 in.	2·70 in.	2·80 in.
White 00	2·19 in.	2·38 in.	2·06 in.	2·07 in.	2·25 in.	2·31 in.	2·28 in.
White 0	2·19 in.	2·69 in.	2·50 in.	2·595 in.	2·69 in.	2·56 in.	2·625 in.
White 1	2·25 in.	2·88 in.	2·50 in.	2·69 in.	2·75 in.	2·56 in.	2·655 in.
White 2	2·70 in.	2·50 in.	2·30 in.	2·40 in.	2·60 in.	2·38 in.	2·49 in.

I found, on an average[2] that a scleral 000 catgut suture takes a pull of about *500 grams. (i.e. 17 oz.)* to tear it out when inserted for purposes of recession, or resection, while the same suture in muscle takes rather less—about 350 grams. (12 oz.).

Lancaster[3] claims that the maximum pull which can be developed (although seldom, if ever exerted) by any eye muscle is about 1000 grams. (34 oz.). I would suggest, therefore, that the minimum safe

tensile strength for a suture at the time of insertion is probably about 30 oz.

In addition to the tension in the wound itself, it is common experience that if sutures actually break, they do so as a rule while they are being knotted. It is interesting, therefore, to note that the "knot break" strength, given in Table II by Speakman, is only about half that of a straight yarn.

Taking the above figures into consideration and allowing for the considerable variation in the strength of all threads when tested by different observers, and the same observer using different specimens, No. 2 white braided silk and even 000 catgut are probably initially unnecessarily strong, and No. 0 white (twisted) silk not reliable enough for deep strabismus suturing (Table III). It

TABLE II

Silk (Boiled Ophthalmic)	Breaking Load (oz.)	
	Straight Break	Knot Break
No. 2 White ...	81·8	52·1
No. 1 White ...	42·8	32·6
No. 0 White ...	19·2	16·4
No. 2 Black ...	104·5	62·8
No. 0 Black ...	20·4	17·1
No. 00 Black ...	20·2	12·3

TABLE III

Material	Tester	Breaking Load (oz.)	
		Straight Break	Knot Break
White Silk, No. 2 (Braided) ...	Speakman	81·8	52·1
Catgut 000	Mead and Ochsner	58	—
Cutgut 000	Localio	48	32
Catgut 000 (Mersuture)	Speakman A	76	41
Catgut 000 (Mersuture)	Speakman B	97	39
Cotton 00	Localio	43	—
White Silk (Braided), No. 1	Speakman	42·9	32·6
Cotton 000	Localio	40	—
White Silk (Twisted) No. 0	Speakman A	39	—
Catgut 0000	Localio	32	16
White Silk (Twisted) No. 0	Speakman B	19·2	16·4

A and B represent different specimens of the same material.

must not be forgotten, of course, that catgut diminishes in strength in the wound, and therefore a margin must be allowed for depreciation.

I have no experience of the use of cotton thread, the figures being inserted for comparison only.

All of us have been annoyed by silk threads pulling out of the eye of a needle during interrupted suturing. The plastic surgeons knot the silk just behind the needle to counter this. The knot catches too much on the conjunctiva or cornea for ophthalmic use, and I would like to draw attention to the ingenious method of pushing the needle through the silk behind the eye of the needle, described by Meyer and Wiener, at the beginning of their textbook[8]. I have found this method most practical, and in conversation that colleagues who have read the book, have completely overlooked the first few pages.

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PHOTOMETER FOR MEASURING THE SCOTOPIC CANDLEPOWERS OF SELF-LUMINOUS OPHTHALMIC TEST OBJECTS

BY

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(THE NATIONAL PHYSICAL LABORATORY)

Abstract

A PHOTOMETER is described with which the scotopic candlepowers of very feeble light sources (down to about 10^{-9} candle) can be measured. Small spots of radium paint, 2 or 3 mm. in diameter and having candlepowers in the range covered, are now used (Livingston) to plot the dark-adapted visual field, and the present photometer was designed primarily for their calibration. The radium paint emits green light but the instrument can be used for

measurements of scotopic candlepowers of any colour. By tests on colour filters whose scotopic transmission factors can be *calculated* from their spectral transmission curves, it is shown that the photometer does, in fact, compare lights on the basis of the scotopic visibility curve of the eye, provided the conditions of measurement are those indicated.

Introduction

In recent researches by Livingston* and other ophthalmologists, the field of vision of the dark-adapted eye has been explored using as test object a spot of radium paint of about 3 mm. diameter mounted at the centre of a small metal disc. The photometer described in this note was constructed for the measurement by a visual method of the very low candlepowers of such self-luminous test objects.

The instrument employs the principle of Maxwellian view and is very similar to the low brightness photometers of Fabry and Buisson, Gehlhoff and Schering, Collier and others, which were designed for determinations of star magnitudes, atmospheric transmissions, etc. The measurement consists essentially of a comparison of the candlepowers of the test object and a standard source of the same size, by a substitution method.

As the self-luminous ophthalmic test objects are used for tests on the dark-adapted eye, it is appropriate for the comparison with the standard to be made at a low photometric field brightness by a fully dark-adapted observer. The intensities of most of the test objects are so low that any visual comparison *must* be made under these conditions. The candlepowers so obtained are not then the ordinary photometric (or photopic) candlepowers but scotopic values. A suitable definition of scotopic candlepower is laid down in this note. Measured values of the scotopic candlepowers of various coloured lights obtained by inserting colour filters in front of a white source are compared with the values computed from the spectral energy distribution of the source, the spectral transmission curve of the filter and the mean scotopic visibility curve of the eye.

Description of the Instrument

The optical lay-out is shown in Figure 1a. A standard source is provided by a small circular aperture A in a brass plate Q mounted on a larger plate P, 4·5 cm. in front of a sheet of flashed opal glass O. The edge of the aperture is bevelled to give the

*LIVINGSTON, P. C.—"Visual problems of aerial warfare," Moynihan Lectures. *The Lancet*, July 8 and 15, 1944.

aperture a precisely defined area. The opal is illuminated from behind by a light source S_1 (uniplanar filament, 4 volt, 4 watt) placed at a suitable distance d and run at such a voltage that the light from it, after diffuse transmission by the opal, has a colour temperature of 2,360 deg. K. From preliminary determinations of the candlepower I of the lamp and of the diffuse transmission factor τ of the opal, the candlepower i of the aperture A in the axial direction can be calculated, given the diameter a of the aperture and the distance d. We have,

$$i = \pi \left(\frac{a}{2}\right)^2 \frac{I\tau}{\pi d^2};$$

for example, if $I = 2{\cdot}0$ candles, $\tau = 0{\cdot}60$
$a = 3{\cdot}0$ mm. $(= 9{\cdot}8 \times 10^{-3}$ ft.)
$d = 12{\cdot}0$ ft.
then $i = 2{\cdot}0 \times 10^{-7}$ candle

In measuring a given test object a standard aperture A is selected which has a diameter approximately equal to and in any case not exceeding that of the luminous area of the test object. Eight standard apertures of diameters in steps from 1 to 4 mm. cover the required range. The test object is substituted for the standard source by extinguishing the lamp S_1 and fixing the test object on the plate P so that its luminous area T takes the place of aperture A.

The plate P and opal O form a unit which can be moved on a length of optical bench to bring the test object T or aperture A to the focus of the lens L_1. The light from T or A is rendered parallel by L_1 and that half of the beam which is not obstructed by the mirror M is brought to a focus by the lens L_2 (power 4D.) in the plane of the eye-ring R. The power of the lens L_1 is such that the image of the test object in R has a diameter equal approximately to 4 mm. and in any case does not exceed this value. Thus the lens L_1 must be chosen to suit the particular test object; a set of lenses of powers increasing in steps from 4 to 16D. covers the necessary range.

At the brightness levels used in the measurements, the natural pupil of the eye has a diameter considerably greater than 4 mm., so that an eye E applied to the eye ring R collects all the light in the image of A or T and sees one half of the lens L_2 uniformly illuminated from that source. The other half of the lens is illuminated in a similar way with light from the comparison aperture A_2 (diameter 2 mm.), an image of which, 4 mm. in diameter, is formed in the plane of R by the lenses L_2 and L_3 (power, 8D.) by way of an intermediate reflexion at the front aluminised mirror M. The very low brightness required for aperture A_2 is obtained

by reducing the light from the comparison source S_2 by transmission through a small aperture A_1 and diffusion at the opals O_1 and O_2. The focussing and centering of the images of the apertures A, A_2 and of the test object are facilitated by inserting in R a tube carrying an eye-piece (Fig. 1b) with which the focal plane of the lens L_2 may be examined. A neutral wedge W (Ilford, clear, density gradient: 0·125 cm.) controls the intensity of the comparison beam, and is adjusted by the observer to bring the two halves of the lens L_2 to equality of brightness.

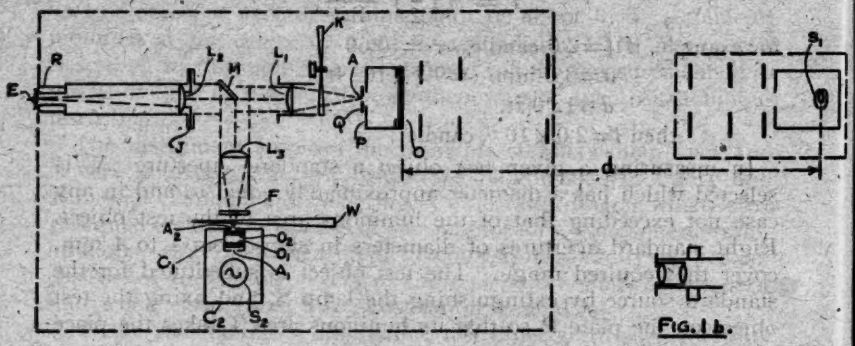


FIG. 1b.

(NOT STRICTLY TO SCALE.)

FIG. 1a.

An iris diaphragm J fitted to the lens L_2 enables the apparent field size of the photometer to be varied. If z is the diameter of the iris expressed in cm. the angular diameter of the field is

$$\frac{z}{25} \times 57{\cdot}3 \text{ deg.}$$

A maximum angular diameter of 8 deg. is obtainable.

The intensity of the test or standard half of the field can be reduced by a known factor by inserting a calibrated sector disk K.

Definition of Scotopic Candlepower

The candlepower of the standard aperture computed in the way described above is the photometric or photopic candlepower. In principle this is derived from a visual comparison with the standard candle by an ideal eye whose relative spectral sensitivity curve (visibility curve) is an internationally agreed average curve

for the eye in the light-adapted or photopic state. The agreed curve is the C.I.E. (1924) Standard Visibility Curve and this curve is implied whenever an ordinary photometric magnitude such as candlepower, brightness, illumination, is specified.

Sources having the same photometric (photopic) candlepower but different energy distributions do not in general appear equally intense to an eye in the dark-adapted or scotopic state. This is because, on dark-adapting the eye, its spectral sensitivity curve is modified, the main change being a displacement of the curve towards the blue (Purkinje effect). At present there is no internationally agreed scotopic visibility curve but a mean curve* based on the results of several investigations has been adopted by the Vision Committee (Flying Personnel Research Committee, Air Ministry). To complete the description of scotopic candlepower, brightness, illumination, etc., a unit of scotopic candlepower must be laid down. In accordance with present practice this unit is so chosen that for "white" light having the same spectral energy distribution as a Planckian radiator of temperature 2360 deg. K, the scotopic and photometric (photopic) candlepowers have the same numerical value. Thus, in this note, by scotopic value will be understood the value based on the Vision Committee's scotopic visibility curve and on a unit of scotopic candlepower which makes scotopic and photometric quantities agree for 2360 deg. white.

Conditions of Measurement

The conditions of measurement with the present photometer are designed to give values approximating to the scotopic values. With this object, the photometric field is large (about 8 deg. diam.), bipartite, centrally divided, and of low brightness. The observer is kept well dark-adapted. Normally he makes matches while fixating on the centre of the vertical dividing line. A greater sensitivity can usually be obtained by fixating on the top point of the dividing line or even on a point on the dividing line produced upwards. If an observer adopts such a procedure he must adhere to it throughout. A device for interchanging the test and comparison lights in the right and left hand halves of the field would be desirable but is not incorporated in the present instrument.

In making a measurement, the test object is set up on plate P and the wedge is adjusted to give a match with the comparison source. The standard aperture is then substituted for the test

*STILES, W. S. and SMITH, T., "A mean scotopic visibility curve," *Proc. Phys. Soc.*, Vol. LVI, p. 251, 1944.

object and, by suitable choice of the sector K, its effective candlepower is adjusted so that on making a match the wedge reading is very nearly the same as that obtained with the test object. This ensures that the test and standard matches are made at approximately the same field brightness. Knowing the gradient of the wedge (determined *in situ* by matches with the standard aperture in conjunction with various sectors K), the candlepower of the test object is calculated by the usual photometric methods.

Save in the special case when the colour of the test light is 2360 deg. white, the answer so obtained will be the scotopic candlepower only if the field brightness and general matching conditions including observer characteristics are such that the standard scotopic visibility curve is operative. The possibility of error through failure to get just the right conditions is greatly reduced by inserting colour filters over the standard and comparison sources, to make their colours (strictly their spectral energy distributions) agree as closely as possible with that of the test object. The spectral transmission curve of the colour filter in front of the standard source being known, its scotopic transmission factor T_{VS} for 2360 deg. white can be calculated, using the relative energy distribution of 2360 deg. white and the scotopic visibility curve. The scotopic candlepower of the standard aperture A with the filter in position is then its candlepower i multiplied by T_{VS}. If the energy distributions of the test light and of the standard light plus filter agreed exactly, the special precautions to ensure matching under scotopic conditions would be unnecessary. In practice, it is not generally possible to obtain a perfect agreement and these precautions must be observed.

By comparing the calculated scotopic transmission of the colour filter with the transmission measured on the photometer an indication is obtained of the extent to which correct scotopic conditions of measurement have been achieved. In measuring the transmission a match is first made with the colour filter in front of the standard source, the comparison field being white. The colour filter is then removed and a sector K inserted to give approximately the same wedge reading. Thus the two readings from which the transmission is derived are obtained at nearly the same photometric field brightness.

Most of the self-luminous test objects measured up to now have emitted a green light which is roughly matched in energy distribution by filtering the 2360 deg. white through a Board of Trade Light Green Glass. The calculated scotopic transmission of the glass used and its value measured in the photometer at several field brightnesses are shown in the following Table.

TABLE I.—*B.O.T. Light Green Glass No. 505.*

Calculated scotopic transmission for Planckian radiation at 2360° K=36·8 per cent.

Calculated photometric transmission for Planckian radiation at 2360° K=16·65 per cent.

Brightness of photometric field (2360° white seen through pupil of 4mm. diam.)	Measured transmission			
	Observer		Mean*	Mean* for 13 other observers
	A	B		
e.f.c.	per cent.	per cent.	per cent.	per cent.
$5·9\times10^{-5}$	37·6	37·2		—
$1·4\times10^{-4}$	39·8	36·7	37·6	—
$3·7\times10^{-4}$	36·7	37·8		—
$4·9\times10^{-4}$	38·0	36·7		36·9
$7·8\times10^{-4}$	35·5	35·9	—	—
$1·7\times10^{-3}$	35·3	36·1	—	—
$3·7\times10^{-3}$	32·4	33·7	—	—
$9·8\times10^{-3}$	28·5	28·9	—	—
$2·1\times10^{-2}$	24·7	30·0	—	—
$3·8\times10^{-2}$	23·3	24·6	—	—

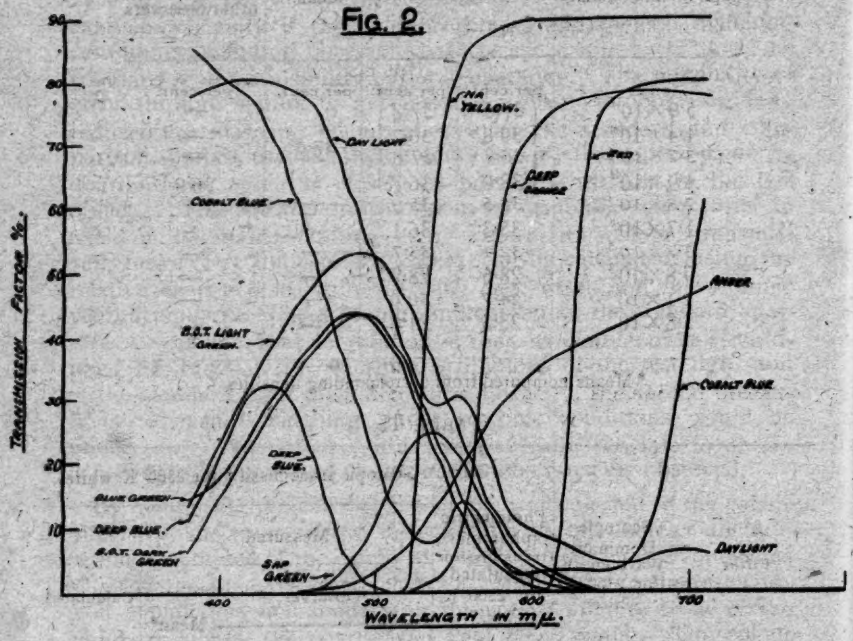
* Means computed from corresponding densities.

TABLE II

Filter	Scotopic Dominant Wavelength (for 2360° K white)	Photometric (photopic) transmission calculated for 2360° K white	Scotopic transmission for 2360° K white				
			Measured				Calculated
			Observer			Mean*	
			A	B	C		
	mμ	per cent.					per cent.
Deep blue ...	460	0·15	1·79	1·95	2·00	1·91	1·94
Cobalt blue	490	7·37	16·4	15·0	15·6	15·6	15·9
Daylight ...	505	19·7	37·5	38·5	33·5	36·4	37·9
Blue green	510	9·35	24·8	25·5	26·7	25·5	25·9
Dark green	515	10·9	28·5	29·0	24·1	27·1	27·6
Sap green ...	530	11·1	15·4	17·2	15·0	15·8	15·2
Na yellow...	545	75·8	38·2	39·6	39·9	39·2	37·5
Amber ...	550	25·7	11·8	11·9	12·0	11·9	11·5
Dark orange	580	42·9	9·82	9·66	9·77	9·75	10·0
Red ...	630	9·74	0·68	1·66	0·64	0·98	0·64

* Means computed from the corresponding densities.

At field brightnesses below about 5×10^{-4} e.f.c. (2360 deg. white seen through pupil of 4 mm. diam.) the measured scotopic transmission is sensibly constant and agrees very closely with the computed value. The conclusion is that for comparisons of white and light greens, the conditions of photometric matching correspond well to those implied in the definition of scotopic candle-power provided the field brightness does not exceed $5{\cdot}0 \times 10^{-4}$ e.f.c. At higher field brightnesses the measured transmission diminishes



and approaches the photopic value, although this is not reached with the range of brightnesses available in the photometer.

The results of tests on other colour filters all made at a field brightness of approximately $5{\cdot}0 \times 10^{-4}$ e.f.c. (2360 deg. white through 4 mm. pupil) are summarised in Table II.

The spectral transmission curves of the various filters used are plotted in Fig. 2.

On the whole, the observed and computed scotopic values agree well. Measurements with the red filter were the most difficult and show the largest difference between observed and calculated

values. It may fairly be concluded that provided the energy distribution of a given test object is roughly matched by choosing a suitable colour filter whose computed scotopic transmission is known, an experimental comparison of the test object with the filtered light will give the scotopic value of the test object with satisfactory accuracy, probably to within ± 12 per cent., except possibly for red test objects. This is true provided the photometric match is made at a scotopic brightness of about $5{\cdot}0 \times 10^{-4}$ e.f.c. (4 mm. diam. pupil) and the result is the mean for at least two " normal " observers.

Acknowledgement

This paper is published by permission of the Director, The National Physical Laboratory.

ANNOTATION

Social and Medical Problems of Phlyctenular Disease in Dublin

This is the title of the Montgomery Lecture, given by Dr. J. B. McArevey, in Dublin on May 3, 1944; in which the author reviews the historical, medical, social and statistical aspects of the problem. Speer in 1822 found "a vast and complicated mass of disease" among the poor, which perhaps was more abundant than in any city of equal size and population in Europe. He attributed the high incidence of disease to social conditions, especially poverty and overcrowding in the slums. Strumous ophthalmia was first reported in Ireland by Ryan of Kilkenny in 1824. Two years later Isaac Ryal gave Ireland its first accurate description of the disease.

Dr. McArevey concludes that the results of his study demonstrate "that basically phlyctenular disease is a manifestation of malnutrition. It is a disease of the poorer class—those whose main source of food is bread and cereals, and from whose diet the essential proteins necessary to growth and normal development are practically absent; the only source of these available to most of them is milk, and that only in limited quantities—in many cases, in the form of free milk. As a necessary concomitant, the affected children suffer from a low grade malnutritional anaemia, with a deficiency of some of the essential vitamins. It is difficult to see how it could be otherwise, in view of the results of my social enquiry, and the facts elicited by the statistical investigations, which reveal the disturbing conclusion that the incidence of the disease, omitting the temporary increase due to the war conditions, has not radically changed since Ryal's day. At this stage one cannot fail to recall his clinical

observations, when over a century ago he attributed this form of disease to 'the want of a due proportion of animal food.'" His summary of the medical investigations shows the sex incidence similar to that of the majority of observers in other countries. Average weights and heights in the phlyctenular children examined show no gross deviation from the normal, apart from a greater deviation in the male, both in weight and height, than in females. The diet was mainly cereals, a low milk consumption and green vegetables were used by only 50 per cent. Apart from milk, in over 50 per cent. cereals were the only source from which proteins could be obtained. There is an almost complete absence of eggs, cheese and fish, and a complete absence of bacon, from the diet.

There was a deficiency of vitamin C in 28·57 per cent. of the group investigated but no deficiency in vitamins A and B_2. There was radiological evidence of rickets in 36 per cent. of the group investigated. Associated illnesses showed a high incidence of measles and whooping cough, a lower incidence of pediculosis than the Dublin school children and a high incidence of cutaneous infections, tonsillar sepsis, dental caries and gland infection. The evidence of tuberculous infection is given under such headings as positive tuberculin tests, radiological evidence, contact and sanatoria.

"The nature of the tissue reaction of the phlycten points to an allergic reaction. The high proportion of positive tuberculin reactions points to the tubercle bacillus or its products as the most possible source of the antyin."

Those who are interested should read the full paper which will be found in the July No. of the *Irish Journal of Medical Science*, 1944.

Dr. McArevey's condemnation of the cereal diet would hardly have commended itself to the Rev. Patrick Brontë, who, we are told, had grown to heroic proportions on potatoes and saw no reason why his children should fare differently, so they always had potatoes for their dinner; but he was not born and bred in an overcrowded slum in Dublin but in the country and perhaps got more milk, eggs and even bacon than the children of this investigation."

We commend this admirable paper to our readers.

ABSTRACTS

MISCELLANEOUS

(1) **Julianelle, L. A. (New York).—Biomicroscopy in trachoma.** *Amer. Jl. Ophthal.*, May 1944, p. 540.

(1) In a discussion at the New York Society for Clinical Ophthalmology **Julianelle** emphasized the stages of hyperaemia, neovascularization, follicle formation and papillary hypertrophy as merely

the result of a prolonged low-grade stimulus. Consequently the diagnosis of trachoma before pannus or scar formation is difficult. The cause of trachoma is a virus, although it differs in incubation period, course and immunity from the usual virus diseases. The detection of the inclusion or mass of virus particles within epithelial cells of the conjunctiva after staining permits early diagnosis. Most viruses have high tissue selectivity and, regardless of their mode of entering the body, invade a particular tissue. Trachoma, showing the greatest selectivity, enters the eye only by way of the eye and can affect only the epithelial cells of the anterior segment. When clinical signs or symptoms appear a full-blown case of virus infection is already present. The sulphonamides have had no success in the author's hands and he is not convinced that they are effective in trachoma, therein his experience coincides with that of the reviewer. Julianelle is the author of "The Etiology of Trachoma" (Oxford Univ. Press, 1938).

A. F. MACCALLAN.

(2) **Elwyn, Herman, M.D. (New York).—Changes in the Fundus of the Eye in Various Forms of Arterial Hypertension.** *Arch. of Ophthal.*, Vol. XXXI (old series Vol. LXXXVIII), No. 5, p. 376, May, 1944.

(2) **Elwyn's** paper is of particular value to ophthalmic surgeons because through routine fundus examination they are often the first to detect arterial disease. There are six main changes:—

(1) Oedema of the retina and disc, due to transudation from the capillaries.

(2) Cotton wool patches, made up of accumulations of precipitated fibrin and serum.

(3) Haemorrhages.

(4) Sharply defined white spots, made up of deposits of hyaline mixed with lipoids and with lipoid-containing fat granule cells, and in the more superficial layers of the retina by ganglio-form swellings of the nerve fibres.

(5) Glistening white spots, from deposits of lipoids and a macular star from deposits of hyaline and lipoids along the lines of the nerve fibres.

(6) Changes in the vessels which are functional, resulting in contraction of the arteries, or organic (*a*) due to ageing in which the elasticity of the vessel wall is diminished bringing about lengthening and widening, producing irregular tortuosity and widening of the light streak (*b*) due to sclerosis in which the essential change is irregular thickening, producing apparent irregularities in lumen of

the vessel and apparent compression of veins at the crossings. The so-called silver wire appearance is due to deposits of hyaline beneath the endothelium of the intima. Some or all of these six changes may be present in any one case. It has been shown experimentally that contraction of a small artery causes dilatation of its distal branches—the precapillary arterioles, the capillaries and the post-capillary venules—with resultant slowing of circulation and lack of oxygen. In consequence, the capillary wall softens and permits passage of its fluid contents into the tissues. Later, small temporary openings develop and allow red blood corpuscles to pass through. These observations account for the development in the retina of oedema, cotton wool patches and haemorrhages, which disappear if the artery regains its normal calibre, as occurs, for example, in recovery from acute glomerulo-nephritis. If the arterial contraction persists, there is then chronic anoxaemia, and deposition of hyaline and lipoids occurs with production of a macular star, of sharply defined and of glistening white spots, also of ganglio-form swelling of the nerve fibres. The various forms of hypertension comprise:—1. Essential. 2. Malignant. 3. Of renal origin. 4. Pre- and eclamptic. 5. Associated with tumours of the supra-renal and pituitary glands.

1. Essential hypertension is regarded as due to breakdown, for hereditary reasons, of an inherently weak central mechanism for regulation of the blood pressure. It is the form most commonly encountered and starts as an increase in the ordinary diurnal variations of blood pressure. It may take 10-20 years before the pressure remains permanently high (at 200 mm. or more) and in the early stages the arteries show no changes. This is because at this time it is only in the vascular bed of the splanchnic region that arterial contraction occurs. In the later stages, the small arteries of the kidneys develop internal thickening with focal deposits of lipoids and hyaline, and in the retina the arteries show the signs of ageing and sclerosis with only occasional development of silver wire appearance. Complications such as venous or arterial obstruction may occur and there may be occasional small cotton wool patches or areas of oedema. In the later stages, papilloedema may develop owing to oedema of the brain consequent on contraction of the cerebral arteries, also arterio-spastic retinopathy. Diagnosis at this stage from malignant hypertension can be made only by the response to treatment.

(2) Malignant hypertension develops in the course of the benign variety, and is characterised by acceleration in the renal arterio-sclerotic process and by general arterial contraction. The fundi, in addition to the changes of ageing, show narrowed arteries, retinal oedema, cotton wool patches, haemorahages, hyaline and lipoid

deposits and a star figure. Papilloedema may also occur and there may be silver wire arteries.

(3) Hypertension of renal origin. In various forms of kidney disease the normal glomerular filtration pressure of 40mm. Hg becomes diminished and the general blood pressure is raised by arterial contraction in order to compensate for this. In acute diffuse glomerulo-nephritis, the retinae show contracted arteries, oedema, cotton wool patches and haemorrhages. If recovery occurs, there is complete regression of all the retinal signs; if this be delayed, however, the secondary lipoid and hyaline changes occur, but even these may disappear with eventual recovery. In chronic glomerulo-nephritis, all possible combinations of acute and chronic arterio-spastic retinopathy may be seen. In the advanced stage, diagnosis from the malignant stage of essential hypertension may be difficult. Chronic, diffuse glomerulo-nephritis unassociated with arterial hypertension produces no fundus changes.

(4) Hypertension of eclamptic origin is due to increased irritability of the centre for regulating blood pressure, bringing about acute spastic contraction of the small arteries in many organs. In the retina this contraction may affect the whole length or only segments of arteries, with resulting oedema, cotton wool patches and haemorrhages. The oedema may be extreme and result in transudation of fluid into the subretinal space, and apparent detachment of the retina. With complete involution of the arteries, the signs disappear.

(5) Arterio-spastic retinopathy resembling the malignant type is seen in cases of supra-renal tumour and in some of basophil pituitary adenoma.

In conclusion, it should be emphasised that acute cases are characterised by retinal oedema, cotton wool patches, and haemorrhages; chronic ones, by deposits of hyaline and lipoids and by a star figure at the macula.

F. A. W-N.

(3) **Walsh, Frank B. and Dandy, Walter E. (Baltimore).—Pathogenesis of intermittent exophthalmos.** *Arch. of Ophthal.* Vol. XXXII (old series, Vol. LXXXIX), No. 1, p. 1, July, 1944.

(3) Intermittent exophthalmos is a rare condition, occurring about once in 150,000 cases, the left eye being affected much more frequently than the right. **Walsh** and **Dandy's** patient was a girl, aged 18 years, who had known of the defect since the age of 10 years. When standing, the left eye showed 3 mm. of enophtbalmos, when recumbent, it showed 6 mm. of protrusion, 11 mm. when the head was tilted forwards or the jugular vein compressed, and 18

mm. when expiration was forced with the nostrils closed. Visual acuity was 20/30 and the fundus normal except for slight venous congestion when the eye was maximally protruded. There was throbbing pain, the throbs coinciding with pulsations of the eyeball, and there was occasional diplopia. The left external and inferior recti muscles were weak, and there was no bruit on auscultation. Operation through a transfrontal approach disclosed a large arterio-venous aneurysm made up of masses of coiled vessels, lying in and behind the left sphenoid fissure. The vessels could be compressed like a sponge and returned to their original size on release of the pressure. They were coagulated by the electro-cautery, and as the feeding vessel appeared to be the middle meningeal artery, this was isolated and coagulated at the foramen spinosum. The result of the operation was to cure the exophthalmos, but although the optic nerve did not appear to be injured at any time, the eye was blind and the disc atrophic. There was also some limitation of movement. The patient, however, was quite satisfied to be relieved of her pain and disfigurement. In a review of the literature, it appears that the age of onset varies from infancy to the sixth decade of life, the symptoms gradually increasing in severity owing to progressive enlargement of the angioma—proptosis up to 29 mm. has been recorded. Various methods of treatment have been tried, the most successful being ligation of the ophthalmic vein through a supra-orbital incision, a procedure which the authors feel inclined to try in their next case, even though it would mean leaving the aneurysm in situ.

F. A. W-N.

BOOK NOTICE

Biomicroscopy of the Eye. By M. L. BERLINER and PAUL HOEBER, New York. Vol. I, pp. 709, 286 test illustrations, 40 coloured plates.

This excellent publication is outstanding from two points of view. In the first place, to English readers accustomed by now to the war time paper, cramped type and lack of illustrations imposed on much of the technical literature in this country, the make-up of the book alone strongly predisposes in its favour. This appears to have been the case even in the land of its production, since it was the only medical book ever included (in 22 years) in the annual exhibit of the Fifty Books of the Year held under the auspices of the American Institute of Graphic Arts. This speaks for itself. The high quality of the paper, the clarity of the type and the brilliance

of the coloured plates place it in the front rank of standard works on the eye.

In the second place the work is outstanding in its comprehensiveness and thorough mastery of biomicroscopy. It deals in the first two chapters with apparatus and technique. The remaining fifteen chapters describe the appearances of the normal and pathological lids, conjunctiva, cornea and anterior chamber, including the angle. Succeeding volumes will presumably carry the investigations further back. Throughout, the greatest attention has been paid to detail and to accuracy of classification. Indeed the book is much more than a treatise on slit-lamp appearances. It is a good reference book on diseases of the anterior segment. Much detailed work on vital staining, on rare dystrophies and on degenerations is collected here in a readily available form. The inclusion of a section on gonioscopy by Dr. Saul Sugar is most valuable as its relation to slit-lamp biomicroscopy is seldom brought out in existing text books. The book in short is a notable contribution to ophthalmic literature.

CORRESPONDENCE

THROMBOSIS OF CENTRAL RETINAL VEIN*

To the Editors of THE BRITISH JOURNAL OF OPHTHALMOLOGY.

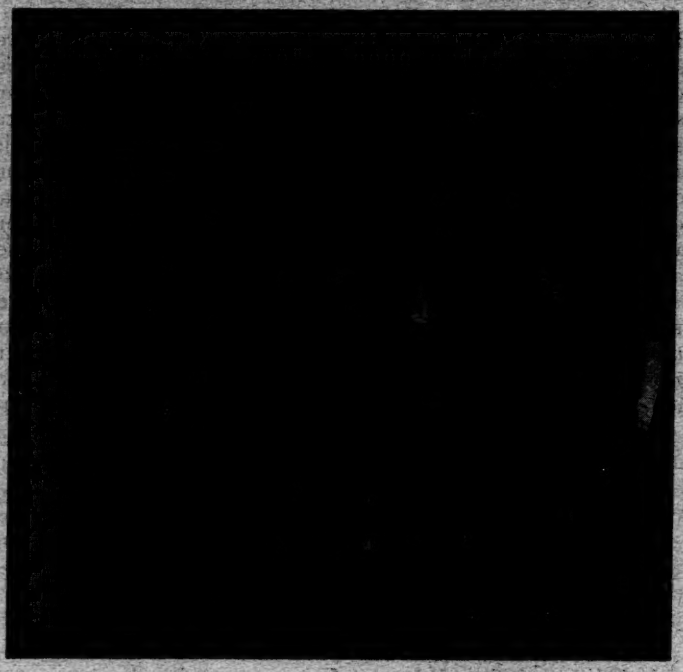
DEAR SIRS,—In your April issue of this year I find a review of "Thrombosis of central retinal vein treated successfully with heparin" by Rosenthal and Guzek (*Arch. of Ophthal.*, Vol. XXX, 1934).

I would like to emphasize the warning issued by the reviewer regarding undue optimism in therapeutic attempts, especially in younger persons.

I submit three retinal photographs of a case of thrombosis of the central retinal vein where the condition took an interesting course.

The patient was a young doctor, aged 24 years, who had always been healthy. He came to the Eye Department of the Hadassah University Hospital, Jerusalem, stating that on awakening he had noticed that he could not see well in his left eye. The ophthalmoscopic examination showed the picture reproduced in the first photograph—marked venous congestion, some haemorrhages, blurred edges of the disc and numerous arterio-venous compressions.

* Received for publication July 31, 1944.



Thrombosis of the central retinal vein, first day.

The vision was reduced to 2/60 and the field of vision constricted concentrically.

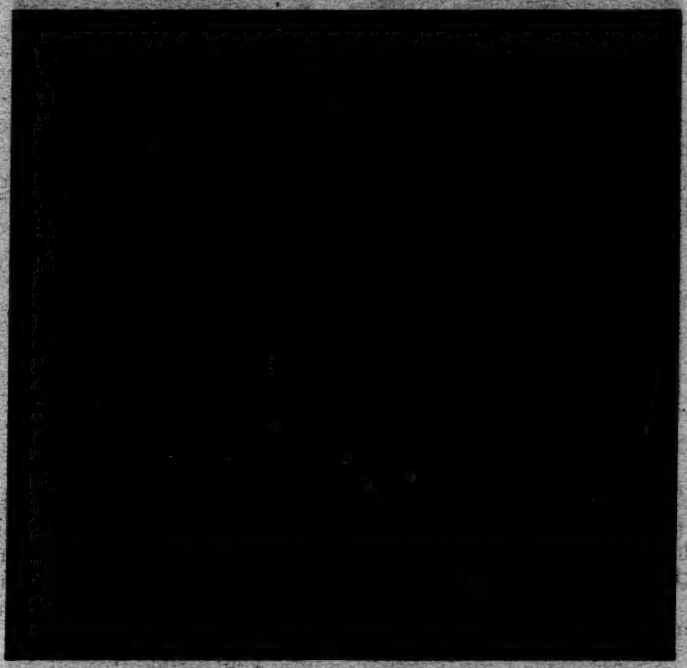
A medical examination did not reveal any pathological findings. The blood pressure was normal so that it can be presumed that the arterio-venous compressions were produced by increased venous pressure.

An X-ray of the accessory sinuses of the nose failed to show any pathological condition, but it had an unexpected result; when the patient rose from the table where the P.-A. view had been taken he noticed that he could see again! In fact his vision was 6/12 and the field of vision was nearly normal but the ophthalmoscopical picture had not changed appreciably.

The patient was admitted to hospital in order to carry out further investigations. When he rose next morning the vision was obscured again and some gymnastic exercises by which he tried to recall the experience of the previous day failed to be effective. The fundus had not changed, and several days later it showed the fully developed

picture of a thrombosis of the central retinal vein reproduced in the second photograph.

The vision then was again approximately 2/60. This condition improved slowly without any therapeutic attempts—heparin was (shall I say fortunately?) not available—and no underlying pathological condition could be found. Finally, after some 8 or 10 weeks, the vision was restored to normal, the field of vision only very



Thrombosis of the central retinal vein, after one week.

slightly constricted, and the fundus showed the peculiar picture reproduced in the third photograph.

Since then over three years have elapsed, the patient has remained in the best of health and the eyesight has not changed. I do not want to go here into the pathogenic mechanism of the condition which would offer a vast scope for speculation. I intend only to show that the complete spontaneous recovery from a condition as serious as this, is certainly possible and so-called "cures" should always be regarded with the necessary scepticism.

Thrombosis of the central retinal vein, after eight weeks.

The surprising first temporary recovery was probably caused by a purely hydromechanical effect of a sudden change of position. The final recovery may be due to the canalisation of the thrombus.

I wish to thank Prof. A. Feigenbaum, head of the Eye Department of the Hadassah University Hospital, Jerusalem, for his kind permission to publish this case.

Yours truly,

H. J. STERN, Major, R.A.M.C.

MIDDLE EAST FORCES,
June 4, 1944.

NOTES

Death

WE greatly regret to record the death on September 30, 1944, of John Lockhart Gibson, M.D., for many years our Brisbane correspondent. He was 84 years of age.

Corrigendum

IN Major R. E. Wright's article on Plastic Spheres for Tenon's capsule, 8 lines from the end, for "filled plastic prosthesis" read "fitted plastic prosthesis." In his second paper the last two lines should read "and the pipette suitably fixed to the eye shield."

In Mr. Bruce Hamilton's letter, p. 424, line 3 "increase" should read "decrease."

* * * *

Corner Cubes: A New Optical Application for Plastics

IMPERIAL CHEMICAL INDUSTRIES has recently elaborated a process of manufacturing special tetragonal prisms from transparent plastics of "perspex." An accurate cube is cut from a block of transparent material and a prism formed by cutting off one corner of the cube. The sheared face of the corner is then polished and has the property of reflecting back along the same path any light ray which is incident upon the sheared face by reason of the inclination of its faces relative to each other. "Thus, a person shining a torch into the prism from any reasonable angle will receive back a strong reflected beam and, provided that the angles of the original cube from which the prism has been cut were sufficiently accurate, no rays would be scattered in any other direction. The maximum

angle of incidence from which a reflected beam will still be received will depend on the 'critical angle' which is itself determined by the refractive index of the material."

Rapidity of production of prisms in very large quantities was assured and a very high degree of accuracy obtained. These corner cubes gave "a reflection from an ordinary pocket torch which could be seen quite clearly at a distance away of more than 150 yards, while the limiting angle of incidence to the normal was 55°."

These corner cubes were mounted in cases containing single and six prisms respectively. The cases were solidly made to withstand rough usage and the joints sealed to make them waterproof.

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British Orthoptic Journal. No. 2, 1944

IF proof were needed that orthoptics has now passed its novitiate and is fit to be admitted as a member of the priesthood of ophthalmology, it is afforded by the appearance of the second number of the British Orthoptic Journal. The variety of the contents and the stimulating nature of the papers cannot fail to be of interest to ophthalmologists as a whole. Many of the papers have a distinctive feminine touch, which mitigates in a pleasant manner the austerity usually associated with scientific journals.

The orthoptists can do a great deal to help ophthalmologists—they can, for example, cure a large proportion of those patients who fail to obtain relief of symptoms from glasses correcting their error of refraction. In Coventry, of 456 individuals who were hampered in the performance of their work, 261 were cured of their symptoms by orthoptic training. It is also possible, by orthoptic examination, to give a reasonably accurate prognosis of the effect of operation for squint, both with regard to the acquiring of binocular vision and the appearance of that bugbear of squint operations, persistent post-operative diplopia.

If these had been its only achievements, orthoptics would have justified itself to ophthalmology as a whole, but there are many more which are described in this Journal; such as the improvement of symptoms after head injury, in disseminated sclerosis and in hyperthyroid states. There would seem to be a big future for this branch of ophthalmology, and one hopes it will not be long before the aspirations expressed in the preface are realised and the orthoptic trainees become an officially recognised body.

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Special Notice

WE are asked by the Ministry of Information to state that the fact that goods made of raw materials in short supply owing to war conditions are advertised in this journal should not be taken as an indication that they are necessarily available for export.

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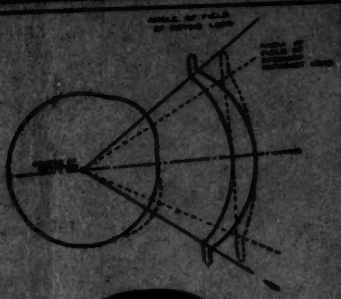
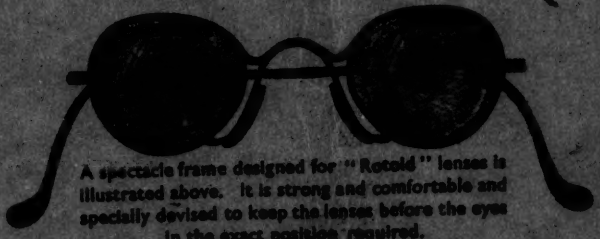
"Rotoid" Lenses are wide angle lenses which give a considerable increased field. They are of great benefit to wearers of high powered corrections, not only as cataract lenses, but also where corrections above minus 10D are required.





A spectacle frame designed for "Rotoid" lenses is illustrated above. It is strong and comfortable and specially devised to keep the lenses before the eyes in the exact position required.

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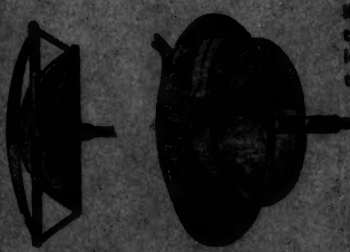

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Printed for the British Journal of Ophthalmology, Ltd., by George Pulman & Sons, Ltd., at 24, Theyer Street, London, W.1